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By JOHN R. DUNLAP

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PRELIMINARY WORK ON THE PANAMA CANAL.

By John F. Wallace.

In this, Mr. Wallace's second paper upon the subject, we have a concise statement of facts which clearly reveal the chaotic condition of affairs on the Isthmus in the spring of 1904, when the Canal Commission took over the property rights and dilapidated equipment of the old French company. No systematic organization, no adequate water supply, no tolerable sewerage system, the quarters for workmen falling into ruins, the mechanical equipment antiquated or practically useless, governmental "red-tape" obstructing the engineers at every step, and even the plan of the canal yet in debate—verily, under such conditions it is remarkable that so much important preliminary work was accomplished.

It is only by studying the subject as a whole and in detail that a clear grasp of the great work can be obtained; and it will be through a perusal of the preceding paper, as well as those which are to follow, that the magnitude of the problem can be appreciated. —THE EDITORS.

THE nine eminent engineers carefully selected by President McKinley, from the army, navy and civil life, who composed the first Walker Commission, and whose consideration of the Canal project extended over the greater part of three years—1899 to 1901 inclusive—estimated that it would cost approximately, $144,000,000, and require ten years (of which two years was held as necessary for the preparatory work) to complete the Isthmian canal on the Panama route, according to the general plan outlined in the report of the commission; the controlling factor as to time in all the Panama projects being the removal of material from the summit excavation at Culebra.

The total amount of material to be excavated and the incidental work connected therewith, for the construction of the canal on a ninety-foot level, in round numbers is 100,000,000 cubic yards—one-

half of which, or, approximately 50,000,000 cubic yards, being contained within the distance of the ten miles embracing the summit cut.

With the single exception of Bohio dam, where the estimate and views of the commission seemed to have been based on insufficient facts, the estimates as to the time and cost appeared to have been well-considered and conservative. It was certainly reasonable to expect that two years should be occupied in preparation for a work of this magnitude and character, even if the general features of the plan had been decided upon.

If the second Walker Commission had considered its functions confined to the construction of a high-level canal as outlined in the report of the first Walker Commission, and as provided for by the Spooner act, and if the various elements of this plan had been fully considered and determined upon to such an extent as to have justified the existing commission in confining itself simply to the execution of a well-considered and settled general plan—then the situation would have been much simplified, and the sequence of organization, preparation and execution would have been substantially as follows:

The organization would include, first, the governmental machinery necessary for the control of the population contained in the Canal Zone; this embracing all of the governmental functions—legislative, judicatory, and executive, providing for the necessary sub-departments, i. e., public schools; courts, civil and penal; police; sanitation and public health; postal; revenue; treasury and accounting departments; and the controlling, collection and disbursement of the government revenues—in fact a complete governmental organization in every detail on a small scale.

The second division of the organization would be that of the engineering department; not, however, along a narrow technical line, but considering that this department would be eventually charged with the administration and execution of all matters connected with the construction of the canal on the Isthmus, except those of a purely governmental nature.

The preparation would consist, first, in the work of sanitation, including a general organization scheme for this department in all its details: Personnel; plans for the repairing and construction of hospitals; devising, and enforcing by proper police regulations, the cleaning of cities, towns and settlements; the drainage of swamps, removal of vegetation; sewerage and water supply for the cities, towns and settlements: and all other sundry preparatory work tending to eliminate causes of disease.

The preparatory work would next consist in the provision of suitable quarters and accommodations, commissary facilities, means of diversion, and other sundry arrangements for the care of the governmental, sanitary, engineering, and construction employes and their dependents; and should consider the necessity of importing almost the entire personnel of the force from a temperate zone, 2,000 miles away, and bring it into an enervating, unhealthful tropical climate.

The importance of the proper treatment of this question cannot be over-estimated; as the basis of efficient and economical results in any organization depends upon the contentment and willing efforts of its personnel.

The third part of the preparation would be the making of surveys and the securing of data for the prosecution of the technical studies, and the preparation of detail plans and specifications necessary for the after-accomplishment of the work, whether it be effected by hired labor or by contract, in whole or in part, as might be afterwards determined.

The fourth feature of the preparatory operations would be the gradual building up of a permanent organization for the administration and execution of the engineering and construction work.

It is evident that this scheme of organization and preparation could not be fully or properly accomplished until the important basic questions of plan and policy had been decided upon.

Various practical considerations made it necessary that, in order to accomplish the best results, these various items of organization and preparation should be carried on simultaneously. Suitable quarters and accommodations could not be provided without organization, supervision, plans and material, which of course, rendered a large force necessary almost at the commencement of the work, which had to be provided with suitable quarters and accommodations.

The installing of sewerage and water supplies in the various town and settlements could not be made without technical studies, plans and specifications, which necessitated the employment of a force for that purpose.

Again, a certain force was also necessary for governmental and executive purposes, embracing not only the office force, but employes of many classes. It was necessary to have a nucleus force of this kind practically from the inception of the work of organization and preparation.

Sanitary arrangements, hospital care, quarters and other accommodations had to be provided for this initial force.

It would seem apparent that the work of organization and preparation must necessarily be one of gradual growth, and, considering the fact that practically all of the persons sent to the Isthmus were unfamiliar with the local conditions, that a large amount of dissatisfaction and discontent would be present among the employes, and the relation of the forces in the various departments and sub-departments would be continually out of balance, until a sufficient time had elapsed to create an experienced, well-seasoned organization. Underlying conditions suggest that this accomplishment would be impossible in a single month or a single year.

At Panama the situation was still further complicated, however, by the fact that the construction work was already being carried on by what was known as the French New Panama Canal Company. While the construction organization was not large or particularly efficient, it was considered the part of wisdom by all, that it should be continued and used as a nucleus for the larger organization to follow. This course was advisable for the reason that a certain amount of excavation could be made regardless of which plan should be finally determined upon.

The persons at the head of the sanitary department were confident of their ability to practically eliminate yellow fever, and reduce and keep within reasonable control the other diseases peculiar to the Isthmian climate.

Over and above all, however, the apparent impatient and undue anxiety of the American people to see "the dirt fly," as expressed through the columns of the press, induced the administration, through the commission, to put forth every effort to secure an early accomplishment.

Immediately after the appointment of the writer as Chief Engineer in June, 1904, he proceeded to Washington for conference with the commission, which resulted in its being considered advisable for him to promptly depart for the Isthmus to make a careful study of the actual conditions from direct personal observation, in order to determine the character and extent of the organization necessary to prosecute the preparatory work.

In company with Col. Gorgas, the chief of the sanitary department, the writer sailed for the Isthmus and arrived at Panama on June 28, 1904, reporting his arrival to General George B. Davis, Governor of the Canal Zone and Isthmian Canal Commissioner, to whom the commission had previously delegated the general supervision of the engineering and construction work—which was under the immediate

charge of Major W. M. Black of the United States Engineers—pending the arrival of the Chief Engineer.

After conference with General George B. Davis, who was acting as managing representative of the Isthmian Canal Commission under the powers delegated to him, the engineering work was transferred to the control of the writer, who actively entered on his duties on July 1, 1904, relieving Major Black, who had been recalled to the United States to resume his regular duties in the Corps of Engineers, U. S. A.

The situation of the Government work and sanitation on the Isthmus July 1, 1905, was as follows: General George B. Davis, as Governor of the Canal Zone, had procured in a preliminary way, the organization of the various departments necessary for the conduct of the governmental zone, and had arranged with the Republic of Panama the tentative delimitation of the Canal Zone, and of the boundaries of the cities of Panama and Colon, which, while inside of the general territorial limits of the Zone boundaries, constituted practically governmental islands belonging to the Republic of Panama, and were retained as part of the territory of that government under the terms of the treaty existing between the United States and the Republic of Panama.

Col. Gorgas, the chief sanitary officer, had also commenced the organization of his department and had taken possession of the former French hospitals situated at Ancon and Colon.

The status of the engineering and construction work was as follows: A corps of engineers under Mr. Charles List, had been placed in charge of surveys, technical studies and other engineering work in the vicinity of Colon, with instructions to secure data and make such examinations and studies as would be necessary to determine the proper treatment of the harbor of Colon, the location of the entrance of the Canal, and the necessary diversion channels between Colon and Gatun, with instructions to make such surveys and borings as would determine the physical characteristics, topography of the ground, and also the sub-formation of the Chagres valley between these points.

Mr. A. B. Nichols with a corps of engineers was situated at Gatun, with instructions to make a thorough study to determine the proper location of the canal and the necessary diversion channels between Gatun and Bohio, and in particular to make such surveys and borings as would determine the physical characteristics and topography of the ground, and the sub-formation of the Chagres valley between these points in order to ascertain the possibility of the location of a

dam in the general vicinity of Gatun, as suggested by Mr. Ward in his paper before the American Society of Civil Engineers.

He was also to study the merits of what was known as the "Tiger Hill Cut-off" as compared with the French location of the canal axis between Bohio and Gatun, the "Tiger Hill Cut-off" having been suggested as an alternate proposition.

Mr. H. F. Dose, with the engineering force under his direction, was assigned to the duty of investigating the physical characteristics of the Chagres valley between Bohio and Bas Obispo, with particular instructions to investigate, by diamond-drill borings, the sub-formation in the vicinity of Bohio, obtaining accurate detail information as to the practicability of a dam in that locality, which, under the plan of the former commission, would create the artificial lake "Bohio," forming the summit-level of the canal at an elevation varying from eighty-five to ninety feet above the sea-level.

Mr. Boyd Ehle, with the engineering force under his direction, was assigned to the duty of conducting the necessary investigations for determining the physical characteristics of the Chagres valley above Bas Obispo, including the hydraulic problems connected with the control of the Chagres river, with special instructions to investigate the practicability of the Gamboa dam site; the accurate determination of the water-shed which would be tributary to that dam; and to make such diamond-drill borings and topographical surveys at that locality as would furnish data and fully decide this question.

Mr. Ehle was further instructed to make such explorations and surveys as would determine the possibility of obtaining a spill-way through the continental divide, into the head waters of the Juan Diaz, thus enabling the surplus waters contained by the Gamboa dam to be discharged onto the Pacific slope; or, the practicability of a spill-way for directing this water onto the Caribbean slope.

It was also his duty to procure the data to determine the possibility —through the construction of a dam at Gamboa or other auxiliary works—of discharging the regulated flow of the Chagres river into the canal prism proper, or through diversion channels parallel to that prism.

Mr. A. C. Harper, as resident engineer, was in charge of the construction work which had previously been carried on under the new French Canal Company at Culebra; and he also had charge of such temporary and immediate repairs as it was necessary to make in order to provide habitable quarters for the preliminary organization of the various departments.

To Mr. C. F. Bertoncini, a former employe of the French Canal Company, and who had been retained as chief draftsman, was given charge of all the engineering records and of the drafting department at the general office in Panama.

Mr. E. C. Toby, a disbursing officer of the United States Navy Department, acted under the direction of General George B. Davis, and had charge of the accounting work on the Isthmus, besides the custody of material and supplies. In addition to these he had other special duties which he was called upon to perform by General Davis.

The writer has not at hand the data to give the total number of the force employed as of July 1, 1904. It is sufficient, however, for the purpose of this paper, to state that it consisted of approximately 1,000 men, which included about 500 natives of the Isthmus, adjoining countries and the West Indies, who were engaged in the construction work; and possibly 500 men of English, American, French, and Spanish nativity, who were employed in the governmental, sanitary and engineering departments. At this time, also, every steamship was bringing fresh employes to the Isthmus, and a few were returning. The mechanical and laboring forces therefore varied largely from day to day, owing to the irregular and spasmodic habits of these classes in a tropical country.

The force and tentative organization thus outlined was that in effect July 1, 1904. No material progress had been made with the surveys and technical studies, prior to July 1, on account of the delay in the shipment of material and supplies to the various engineering parties in the field. Also, owing to the shortage of material and the scarcity of *skilled* labor, only insignificant repairs had been made to the buildings—about 2,500 in number—erected by the original French company, which were in a condition of more or less dilapidation and ill-repair.

As to the construction work, the French records show that during the four years preceding the 1st of June, 1904, approximately 57,000 cubic yards of material per month had been removed from the Culebra cut. This material, however, had been roughly estimated by Jamaica negroes, to whom was assigned this duty, and who practically guessed at the contents of the loose material loaded into the cars, which were often only partially filled. Although the French engineers had very carefully determined the ratio of the solid measurement to the loose material in the cars, the cars were not uniformly loaded, and as the ratio evidently varied also with the character of material loaded, this

seeming accuracy was somewhat misleading. Estimates were not made from measured cross-sections.

Again, a portion of this material was deposited upon the spoil-banks inside of the cross section of the probable ultimate excavation. During the ten months previous to American control, this average output had been reduced to approximately 25,000 cubic yards per month. These figures are approximations arrived at from the data contained in the report made by Major Black, as the result of his observations and investigations of the methods and measurements employed during his period of residence on the Isthmus. The falling off of the output had evidently been brought about by the desire of the French company to spend the minimum amount of money, pending the time when the work would be finally transferred to the control of the United States.*

Prior to the arrival of General George B. Davis upon the Isthmus, May 17, 1904, the entire line of the canal, with the exception of the Culebra excavation, was covered with a dense jungle, and machinery and supplies were scattered along the route of the canal as they were left at the collapse of the old Isthmian Canal Company, when the work was finally suspended by the liquidator on the 15th day of May, 1889, fifteen years previously.

Such material and supplies, however, as were stored in the warehouses of the canal company under the charge of the material and supply department, and unissued, were in fairly good condition, and were systematically stored, arranged, tabulated, and properly cared for; thus contrasting strongly with the condition of the machinery and material issued to the agents and contractors distributed over the line of the work.

Prior to the arrival of the Chief Engineer on the Isthmus Mr. Charles A. Strom had been engaged as a mechanical engineer, and in connection with a Commissioner, Mr. Frank J. Hecker, commenced a systematic examination into the condition and efficiency of the machinery and supplies above mentioned, the original cost of which, as charged on the books of the French company, approximated $29,000,000.

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* In this connection the writer desires to state that much interesting matter containing the results of Major Black's observations and examinations during the period in which he had charge of the work on the Isthmus is to be found in a series of reports made to Admiral Walker, Chairman of the Commission, and which, while on file in the office of the Panama Canal Commission, were not officially published. The writer, however, had a few copies of these reports printed at Panama for the benefit of his staff.

During the fifteen years that had elapsed since the work had been abandoned by the liquidator of the original French company and the formation of the new company, no particular attention had been paid to sanitation on the Isthmus and at Colon, or along the line of the work. While the death rate had been lowered as compared with the situation during the De Lesseps' régime, this was due to the fact that the resident population had become more or less immune, and that fresh material had not been supplied for the yellow fever and other malignant Isthmian diseases to feed upon.

Owing to the constant flow of South and Central American travel through the Isthmian gateway to and from other infected points, it was obvious to the Commission that the first step was to properly sanitate the cities of Panama and Colon, and secondarily the Canal Zone; and afterwards, by the rigid enforcement of a quarantine to prevent the admission of new infection.

As a primary condition to successful sanitation, pure water and adequate sewerage systems are indispensable; and before setting sail for the Isthmus, the writer secured the services of Mr. Carleton E. Davis as engineer of sewerage and water-supply, instructions being given him to organize his force and proceed to the Isthmus at the earliest possible date.

Prior to the arrival of Mr. Davis, the writer made a careful study of the various proposed systems of water supply for the city of Panama, which had heretofore been under consideration. At the suggestion of General Davis, special attention was given to the utilization of the head waters of the Rio Grande river at a point near the south end of the Culebra cut, where a small reservoir had been constructed by Mr. P. Bunau Varilla, at one time Chief Engineer of the Panama canal, the object being to supply water used in the excavation of the Culebra work.

The advantage of this location consisted in the fact that the United States government owned the entire water-shed, and that only two habitations had previously existed within its limits; that the water could be conducted along the right of way immediately adjacent to the railroad, requiring no negotiations for land, and admitting of the most economical construction, besides supplying the Panama railroad and adjacent territory along the canal with water for a distance of ten miles between the site of the reservoir and the city of Panama.

After comparing this source with others suggested, the Chief Engineer instructed Mr. Davis to investigate and report upon its utilization immediately upon his arrival. A careful investigation and

analysis of the water and sources of supply resulted favorably, and on August 9, 1904, the Chief Engineer forwarded the Commission a report on the proposed water-supply system for the city of Panama, recommending its immediate construction at an estimated cost of $440,000. This estimate provided not only for the necessary reservoirs and main supply line, but also for a complete distributing system in the city of Panama. The location of the reservoir on the Rio Grande also assisted in solving the problem of taking care of the flood-waters of that river.

The system consisted of a main impounding reservoir, at an elevation of approximately 235 feet above the level of the sea, containing enough water to supply the city of Panama with 2,000,000 gallons daily—an average of sixty-six gallons per inhabitant, per day, on the basis of 30,000 population, which was at least fifty per cent. in excess of the present number of inhabitants—and continuing this supply for four consecutive months, without any addition to the supply in the original reservoir—should that improbable circumstance ever occur—the reservoir still holding sufficient water at the expiration of this period to preserve its potable quality.

This water was to be conducted to the immediate vicinity of Panama through a sixteen-inch main, and discharged into an auxiliary reservoir of 1,000,000 gallons capacity, situated at an elevation of approximately 140 feet above the sea level in the immediate vicinity of Panama, from which the water was conducted through a twenty-inch pipe to a connection with the distributing system in the city.

Numerous delays occurred in the construction of this water-supply system, due to the fact that the last shipment of sixteen-inch pipe for the water main did not arrive on the Isthmus until May, 1905—eight months after the requisition had been issued for it. The system was in final readiness for the delivery of water in the city of Panama at the close of June, 1905, although the auxiliary reservoir and the full local distribution would still require several months for completion. The relation between the principal water-main and the storage reservoir is such as to permit the water to be furnished to the city through a by-pass, directly from the collecting reservoir.

Simultaneously with the construction of this water-supply, plans and estimates were made for the construction of a sewerage system at an estimated cost of $275,000. The out-fall sewers had been constructed, and the work of installation of intercepting and lateral sewers was well under way at the close of June, 1905.

Even in the United States, it is rare indeed that a water-supply

of this magnitude is conceived, designed and executed in so short a time; and considering the delays in securing the material, and especially the difficulty experienced in obtaining the proper quality and quantity of labor, the result of this particular installation was certainly gratifying. And the credit therefor is due to Mr. Carleton E. Davis and his efficient staff of assistants.

During the same period, Mr. Davis, through his staff, conducted surveys and furnished estimates and plans for the installation of a water supply for the city of Colon. The situation at that place being much more complicated than at Panama, it will require another year to construct the system. It will be necessary to change and raise the grade of the entire city before water and sewerage can be fully installed, and it will also be necessary to procure, either by purchase or condemnation, the land needed for the collecting reservoir and connecting mains.

Various minor reports and plans were also made by Mr. Davis and his staff for the installation of water-supply and sewerage at the various points along the line of the canal, the construction of which was generally well under way on June 30, 1905.

In addition to proper water-supply and sewerage for Panama, it is obvious that in order to maintain a proper state of cleanliness, the city should be provided with street pavements. Plans and estimates had been made for this purpose, but the question of the power of the Commission to make this expenditure in the city of Panama resulted in no action being taken to authorize the work until the appointment of the last new commission on April 1, 1905; and it was not until May that authority was received by the Chief Engineer to make requisition for the proper material.

The plan provides for three classes of pavement: In the central part of the city, a vitrified brick pavement laid on a concrete foundation; in other streets, vitrified brick pavement laid upon a macadam foundation; and on the outlying roads, macadam pavement, the estimated cost being $425,000 for the entire work.

The importance of providing suitable quarters for the increased force, which every steamer was bringing to the Isthmus, was thoroughly realized by the Chief Engineer upon his arrival, and on July 12, 1904, Mr. M. O. Johnson was appointed supervising architect, in charge of the construction, repair and maintenance of buildings. Mr. Johnson immediately proceeded to the Isthmus, and organizing his force, pushed the work with intelligence and vigor, although the dis-

advantages under which he labored were most discouraging. The mechanics immediately available and who could be secured from the surrounding countries were incompetent, shiftless and lazy; and owing to the governmental methods which surrounded the purchase of material at Washington, at no time during the year was there sufficient material on hand to meet the immediate requirements, although the material and supply department purchased everything offered in the local markets on the Isthmus.

One of the difficulties met with by the architects' department in caring for the existing buildings was that it was not easy to determine, until the buildings were in actual process of reconstruction, the full extent of the repairs needed, owing to the ravages of time. In some of the buildings which seemed substantial, when the floorings and sidings were removed, the beams, joists and hidden timbers would be revealed and found to be in poor condition, attributable to the effects of the climate and destruction by white ants.

It was generally the case that much more material was needed in repairing the buildings than could be determined by casual inspection before the work commenced: and as such a large number of buildings were supplied by the original French company, the Isthmian Canal Commission was naturally disinclined to make expenditures for the construction of new buildings, presuming that the repairing of existing structures would be sufficient to supply accommodations.

In February, 1905, however, authority was given for the construction of eight hotel buildings, providing general quarters for the staff; and by the first of May two hotels, three stories high and containing eighty rooms each, were erected, one near Corozal and the other at Culebra. These were completed, furnished and occupied prior to June 1, 1905.

Authority was also received for six other buildings of the same class, and plans had been made for their erection immediately upon arrival of the material. It is needless to enumerate the large number of buildings that were put in temporary condition for habitation.

This work was carried on in the following way: First, the temporary and immediate repairs of buildings to such an extent as would permit of their being inhabitable. Second, thorough repairs in order to place them in proper condition. Third, construction of additional new buildings.

On the 1st of June, 1905, 1,499 persons were employed in the architects' department, 211 of whom were Americans and skilled mechanics paid in gold, and the remainder mechanics and laborers, more

or less skilled, drawn from the population of the Isthmus or the surrounding countries.

Mr. Johnson, who was efficiently conducting this department, worn out by the strain and responsibility which rested upon him, and further weakened by the debilitating effects of a tropical climate, was stricken with yellow fever, and in the latter part of April, 1905, fell a victim to the disease. However, his successor, Mr. Burt, assisted by Mr. Wright, took up the burden and work, and enthusiastically carried it forward.

Complaint as to lack of quarters was due to several causes, the first being the fact that the majority of the men imported from the United States evidently expected to find all of the conveniences and comforts of modern civilization available in eastern United States cities, and came unprepared and unwilling to put up with even temporary hardships and inconveniences, which are inevitable during the period of preparation and organization of construction work of this character.

Again, the employes in the departments of engineering and construction alone, on the 1st of June, 1905, had increased during the preceding year to approximately 7,639 men. This does not include the members of their families or those indirectly connected with the work, but only the names of those actually at work and on the payrolls; it does not include—figures for which are not at hand—the persons employed in the governmental, sanitary and other departments of the work, which would doubtless swell the total to over 10,000, ten per cent. of whom were actively engaged on the 1st of June providing quarters for the remainder.

There is no doubt that the present force could have been better provided for if the simple and established business methods could have been used that are everywhere employed in private enterprises for securing and furnishing men and material.

While working under the jurisdiction of the Walker Commission, prior to April, 1905, the chief of what was called the department of material and supplies was not under the control of the Chief Engineer, but reported to and received directions from the Chairman of the Commission; and it was not until the writer returned to the Isthmus in the latter part of May, 1905,—after the reorganization of the present commission—that the materials and supplies on the Isthmus were placed under his control, and a bureau of supplies was instituted.

The principal American commissary on the Isthmus was that under the control of the Panama railroad, which furnished such supplies as were required by the American employes, either to these employes direct or through the medium of the proprietors of such hotels and canteens as were established for their accommodation.

The regulations of the disbursing department, which prohibited deductions from the pay of employes for the benefit of proprietors of hotels and canteens, in liquidation of bills, was a serious difficulty, as it made the collection of board bills troublesome.

Under the circumstances it was difficult to procure qualified and competent persons to operate or establish boarding-houses and canteens. An alternate plan was the establishment of these facilities and their operation by the Commission.

Up to the date at which the writer left the Isthmus, no plan had been devised which would conform with the governmental regulations, and was practicable and workable under the conditions.

During March and April, 1905, the Panama railroad commissary was temporarily transferred to the control of the material and supply department of the Isthmian Canal Commission. Under the law that the gross receipts of all supplies sold would have to be covered into the treasury of the United States, and all payment for commissaries charged out against the Canal Commission, this department was retransferred to the Panama railroad, in order to avoid this complication, as the amount of all merchandise purchased for the commissary department would have fictitiously increased the cost of the canal to the amount of these purchases.

Under ordinary conditions, the providing of proper facilities for the feeding of employes would have been a very simple matter—if unhampered by governmental regulations and handled by the common-sense methods used by contractors conducting large construction operations.

The writer has intended in the foregoing pages to briefly indicate the situation on or prior to July 1, 1904, when he was placed in charge on the Isthmus; together with a brief description of that part of the work under his charge relating to water-supply and the sewerage necessary to supplement the work of the sanitary department. A subsequent article will treat of what was accomplished under the direction of the engineering and construction departments during the year ending June 30, 1905.

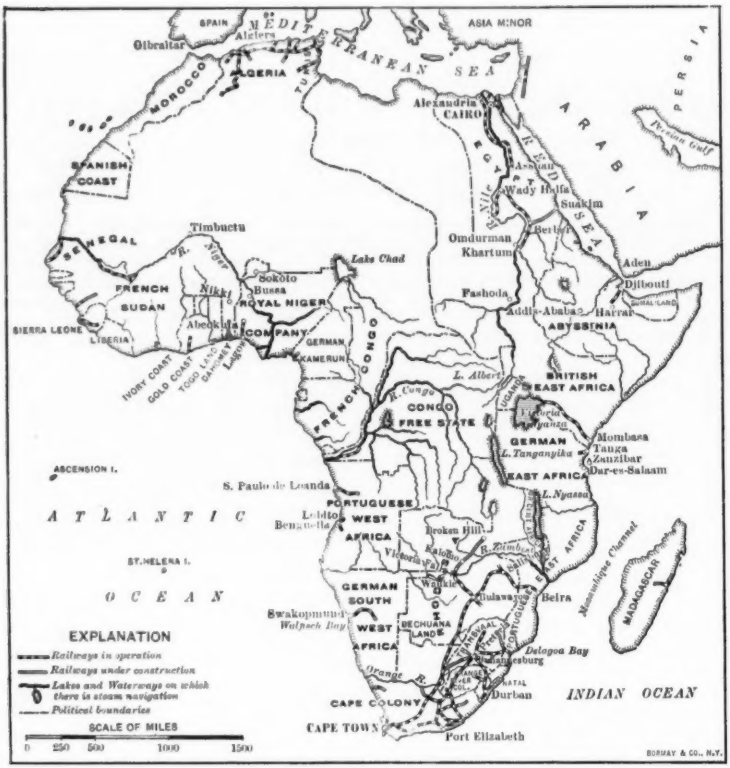
RECENT PROGRESS ON THE CAPE-TO-CAIRO RAILWAY.

By J. Hartley Knight.

The recent opening of the bridge over the Zambesi River at Victoria Falls, and the South African meeting of the British Association this summer, when the members travelled by rail to this great cataract in the heart of Africa, have directed attention to the progress which the Cape-to-Cairo Railway is making, and in the present article Mr. Knight gives a most interesting account of the status of this tremendous undertaking, and also describes some of the branch roads from the coast, which will act as the feeders of the main trunk line, and which, in turn, will be fed by it.—THE EDITORS.

FIVE years ago I was privileged in these pages to relate in some detail the story of the inception of the Cape-to-Cairo Railway scheme and to give an account of the work then actually accomplished. It may be remembered that in the endeavour to trace the origin of the scheme I showed how, in 1879, Sir (then Mr.) James Sivewright, at that time telegraph superintendent to the Cape Government, had conceived the idea of connecting the south of Africa with the north by means of a telegraph wire; and I further showed that the Cape-to-Cairo project was foreshadowed in 1888 by Sir Charles Metcalfe, Bart., who was inspired with the idea of calling the prospective Bechuanaland Railway the "Central African Trunk Line." In a word, I questioned the popular opinion that the scheme had originated in the fertile brain of the late Mr. Cecil Rhodes, at that time happily still with us,—although I gave, or tried to give, full credit to that distinguished statesman for having, as it were, crystallised the idea, and materially assisted to popularise it by the wonderful enthusiasm he displayed and the practical support he lent to its realisation. I did not then know, although I have since been informed of the fact, that the phrase "Cape to Cairo" was first actually employed by Sir Charles Metcalfe, who used it in an article he wrote for the *Fortnightly Review* somewhere in the year 1889.

The purpose of this article is, however, not to discuss a matter which is after all not of very great consequence, but rather to show how the scheme has progressed during the past five years. When death removed from South African political life the dominating personality of Mr. Rhodes, there were not wanting those who predicted the speedy abandonment of the "fantastical Cape-to-Cairo Railway scheme." There was perhaps some justification for this belief because,



AFRICAN RAILWAYS AND WATERWAYS.

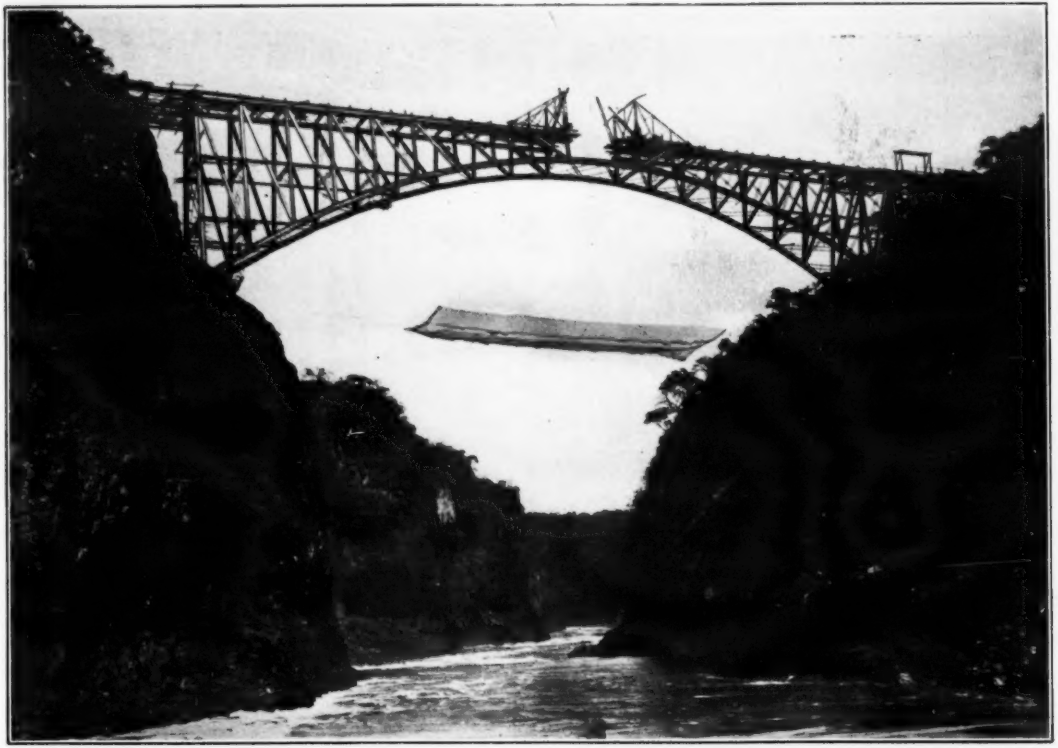
as I showed in my previous article, Mr. Rhodes's name was so indissolubly bound up with the scheme that many thought that the demise of the one assuredly meant the death-blow of the other. But as events have proved, the project has not suffered in any way—certainly not so far as the southern portion of the line is concerned. The position created by Mr. Rhodes during his lifetime was such that his work was bound to go on after his death. This was very clearly explained at the time of Mr. Rhodes's death in a note issued to the shareholders of the British South Africa Company by the late Mr. J. F. Jones, the joint manager and secretary, who, in the course of a dignified tribute to his chief's memory, observed:—"It is not the least result of the work of Mr. Rhodes that the destinies of Rhodesia and

VICTORIA FALLS.

The falls are over 400 feet high and about a mile wide from bank to bank, with several islands intervening.

of the company have ceased to depend upon the life of any individual. The organisation which was due to his genius has been established upon a permanent basis. The development of the natural resources of Rhodesia will continue and the finances of the company are to-day equal to any strain that is likely to be cast upon them." Possibly had Mr. Rhodes lived the project as a whole would to-day be more advanced than it is—particularly in the regions north of Rhodesia—but so far as the sub-continent is concerned it is surely matter for congratulation to all concerned that so much good solid work has actually been accomplished.

Quite recently I had the opportunity of discussing this very subject with Sir Charles Metcalfe, who, *en parenthèse,* has been the leading spirit of the railway all through. I told him that in some quarters the impression still remained that the death of Mr. Rhodes had adversely affected, and was still affecting, the great railway scheme. Now, as Sir Charles Metcalfe is so closely associated with the project it was perhaps hardly fair to expect him to say very much either way, but he agreed with me that, so far as he was aware, the railway scheme had not suffered to any appreciable extent, if indeed at all, by the



ZAMBESI RIVER BRIDGE, SPANNING THE GORGE BELOW VICTORIA FALLS.

demise of his lamented friend; and he added that if it were otherwise the line from the south would scarcely be where it is to-day, namely, a good many miles beyond Kalomo and well on the way to Rhodesia Broken Hill, the next great stage to the terminus on the southern end of Lake Tanganyika. "It must be admitted," Sir Charles proceeded, "that Providence has been very kind to us in regard to the stretch of country north of Bulawayo, in that we have coalfields at Wankie to help us along and are now making straight for Broken Hill which, as you are aware, is a rich copper region." He further stated that some people seemed to think that sentiment was at the bottom of Mr. Rhodes's plans respecting the railway, whereas the latter had always regarded the matter from a hard-and-fast business standpoint. "The fact that we are where we are to-day with the railway shows, I think," Sir Charles Metcalfe added, "that we are doing what Mr. Rhodes would have done." What my interviewee said about the supposed underlying sentiment is, in a measure, borne out by Mr. Rhodes himself in a letter he addressed to a young Cambridge graduate, to wit, Mr. Ewart S. Grogan, who has the distinction of being the only white man who has traversed Africa from south to north. Such a feat, said Mr. Rhodes in effect, "makes me the more certain that we shall complete the telegraph and railway. . . . As to the commercial aspect, the object is to cut Africa through the centre and the railway will pick up trade all along the route. The junctions to the east and west coasts, which will occur in the future, will be outlets for the traffic obtained along the route of the line as it passes through Africa. At any rate to Bulawayo, where I am now, it has been a payable undertaking, and I still think it will continue to be so as we advance into the far interior."

The extension of the line to the Wankie coal district, northwest of Bulawayo, was in contemplation at the time my former article appeared in THE ENGINEERING MAGAZINE. Owing to the Boer war the work was somewhat retarded. It was originally intended that the line from Bulawayo via Gwelo (and thence to Salisbury and the Portuguese port of Beira) should form the first section of the main line northwards from Bulawayo towards Tanganyika. It was also intended that the line should traverse the Mafungabusi district and cross the Zambesi in the vicinity of the Kariba Gorge. It was, however, found on further examination of the proposed route that the country north of the Zambesi at that point is very difficult for railway construction. "Further,"—I am now quoting from the British South Africa Company's official report—"though the indications of coal in

the Mafungabusi district are numerous and promising, sufficient work had not been done to enable the economic value of those fields to be compared with that of the Wankie coalfields." Thus it came to pass that the Wankie route was selected, the wisdom of which step has since been made manifest. The line—203 miles in length—was begun in May, 1901, and finished in September, 1903.

Then was commenced what by many is regarded as the most interesting portion of the southern half of the Cape-to-Cairo Railway, namely, the section which includes the world-famous Victoria Falls. The link in question—from Wankie coalfields to the Falls, some 75

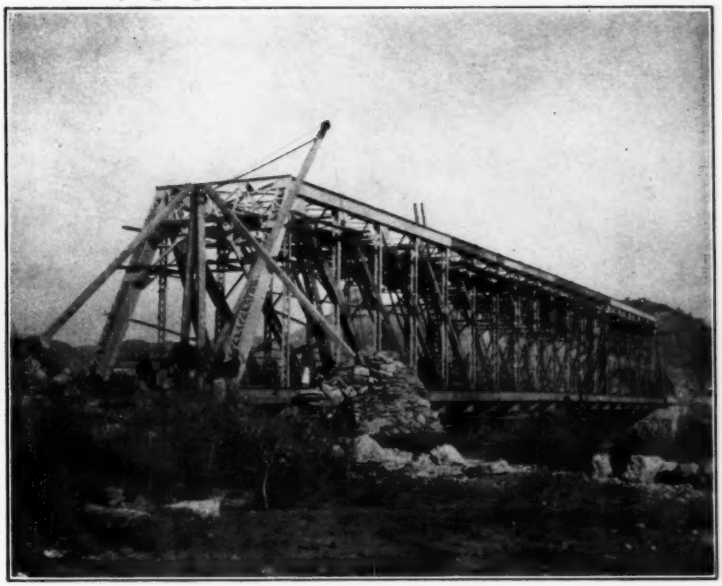
ZAMBESI RIVER BRIDGE AT VICTORIA FALLS.

Day of linking in, April 1st, 1905. The net underneath is for the purpose of catching workmen and tools which may fall from the structure.

miles—was begun on the 21st of September, 1903, and finished on the 25th of April, 1904, and the whole line from Bulawayo to the famous cataract was opened for traffic on the 20th of June. A few weeks later the first through train from Cape Town started amid enthusiastic demonstrations. It is interesting to record that the first locomotive to cross the River Zambesi at the Victoria Falls was taken over by means of an enormous cableway spanning the gorge, as the bridge was not then built. It was necessary to entirely dismantle the engine and draw the tubes from the boiler in order to reduce the

weight sufficiently to enable the cableway to deal with it. The heaviest piece that was taken over weighed about nine tons.

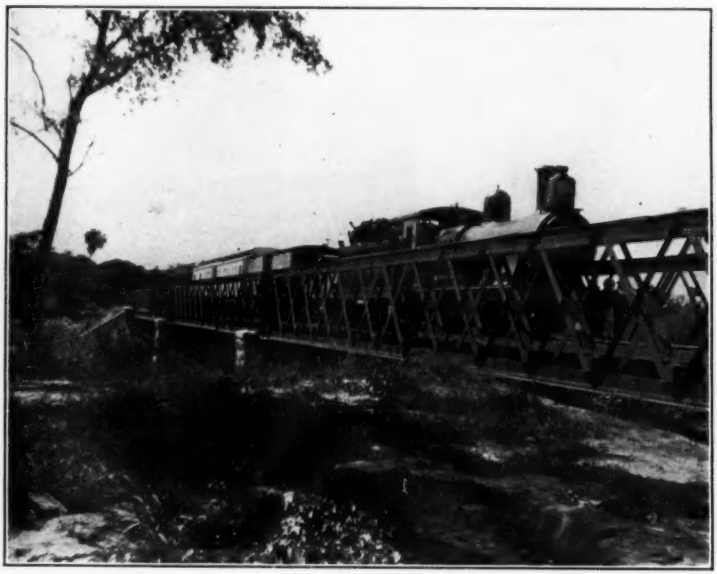
Whilst the bridge was building the work of laying the metals on the track north to Kalomo was proceeded with, all the material for that section being conveyed across the gorge by the so-called "Blondin" transporter, which did splendid work in this particular. The cable to which the transporter was attached was of steel and was fixed to a steel tower on either side. The transporter, driven by electricity, and with a carrying capacity of five tons, took across the sections of half



CATUMBELLA BRIDGE, LOBITO BAY RAILWAY, PORTUGUESE WEST AFRICA, 350 FEET LONG.

the bridge, as well as the rolling stock, and all the material for 50 miles of roadway. The Zambesi bridge, or the Victoria Falls bridge, as it is variously called, is a record bridge in many respects. It is the highest—420 feet—in the world, and it was built in the shortest time recorded for such a work, viz., nineteen weeks. Sir Charles Metcalfe also claimed that no other bridge of its size and capacity had ever been built so cheaply. At the time of writing the bridge is still incomplete, some 50,000 rivets having yet to be hammered in before the finishing touches can be made. The bridge was designed by Sir Charles Metcalfe, consulting engineer in Africa of the Rhodesia Rail-

ways, Limited, and Mr. G. A. Hobson, M. Inst. C. E., of the firm of Sir Douglas Fox and Partners, the same company's consulting engineers in London. The work of construction was under the immediate charge of Mr. G. C. Imbault, who had with him a staff of English bridge builders, which never exceeded 25 men, and about 100 native labourers. This gentleman practically superintended the construction of the bridge at Darlington, where it was made by the Cleveland Bridge and Engineering Company, and also its erection across the Zambesi. The total length of the bridge is 650 feet, of which the



GWAAR BRIDGE, 90 MILES FROM BULAWAYO ON THE WAY TO VICTORIA FALLS.

central span accounts for 500 feet between the pin centers on the two banks, the balance being made up of the two short spans. The great center span rises in a graceful parabolic arch to the center, the spring of which starts from the bases of the main booms. The vertical rise to the crown is 90 feet. The main span is made of 20 bays each 25 feet long; and lateral stability was secured by a wide spread at the feet of the bridge. At the rail level the distance between girder centers is 27 feet, 6 inches, whereas at the bases the width between pin centers is 50 feet. The roadway projects beyond the side girders so as to allow a clear 30 feet between parapets. The bridge is of steel, and as it is

coated with grey paint it is rendered as invisible as possible against the cloud of spray—"the smoke that sounds," as the natives call it—that rises from the Falls and the undue obtrusion on the landscape which so many feared has thus been obviated.

According to Mr. G. A. Hobson, the most difficult portion of the work was at the beginning. It was anticipated that the footings of the bridge could be formed of the face of the solid rock, but a closer inspection revealed the fact that the surface was covered to a considerable depth with loose debris, which had to be cleared away. The re-

TRAIN AT THE GWAAR BRIDGE, VICTORIA FALLS LINE.

sult of this was that it was found necessary to place the bridge at a level 21 feet below that originally selected and to set the hinged base pins in foundations of armoured concrete. "Once we began to build the arch outwards from either bank," said Mr. Hobson, "everything was plain sailing, and the work went on with the smoothness and regularity of clockwork." So carefully had the whole thing been thought out that the two ends of the bridge, which was built from both sides on the gorge simultaneously, met so exactly that there was not a difference between them of even an eighth of an inch. The actual erection of the bridge commenced on October, 1904, and the girders were joined on April 1, 1905.

During the construction of the bridge across the Zambesi the laying of the railway in a north-easterly direction to Kalomo went on uninterruptedly at the rate of a mile and a half per diem, and only a few weeks back the welcome intelligence reached London that the objective, a little under 100 miles, had been reached. From Kalomo to Broken Hill is 260 miles, with the River Kafue almost half way between. Here a bridge, some 1,700 feet long, will have to be constructed. It is anticipated that the line will reach the zinc and copper districts in June next year. Engineering difficulties en route there are practically none. The country being free from undulations it is proposed by the Rhodesia Copper Company to construct a light line to connect the various mining properties of the company, so that in the fulness of time this district is likely to be a network of railway lines and a scene of great commercial activity. I understood from Sir Charles Metcalfe that for the present at all events no definite arrange-

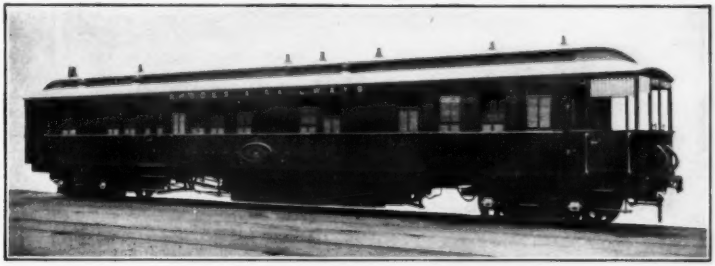
DOUBLE-BOGIE KITSON MEYER LOCOMOTIVE, RHODESIA RAILWAYS.
Designed for sharp curves and heavy traffic.

ments have been made to carry the line beyond Broken Hill, and he politely begged to be excused when I pressed him for an approximate date for the arrival of the iron horse at Abercorn, on the southern end of Lake Tanganyika. "My own opinion," remarked the baronet, "is that in the future there will probably be two lines running from Broken Hill—one going up through the Congo Free State, to Lake Chad and right through French territory, coming out perhaps at Algiers or some other place on the north coast; the other coming up through German East Africa and ultimately joining up with Khartoum and Cairo."

For the time being, then, the railhead of the Cape-to-Cairo Railway will be at Rhodesia Broken Hill, which is about 1,984 miles from Cape Town. When the next section will be taken in hand will depend very much on circumstances, chiefly, it would seem, of a financial character. And whether too, the route favoured by Mr. Rhodes will ultimately be followed and the waters of Tanganyika utilised in preference to constructing a line on its eastern bank also remains to be deter-

mined. Sir Charles Metcalfe favours the railway line in preference to the waterway, but I think it is exceedingly doubtful whether that line will ever be constructed, railway construction in that part of Africa, which is German territory, being eyed somewhat askance by the powers that be in Berlin.

Turning once more to my article in THE ENGINEERING MAGAZINE of five years ago I find that I said:—"In twenty years' time, it is safe to prophesy, railway development in Africa will have made enormous strides, and many important branch lines to connect with the Cape-to-Cairo trunk will have been constructed or be near completion." Already very considerable progress has been made in this direction, and among other lines which have been completed since the statement was made is that between Bulawayo and Beira—viâ Salisbury—in Portu-



PRIVATE SALOON CAR, RHODESIA RAILWAYS.

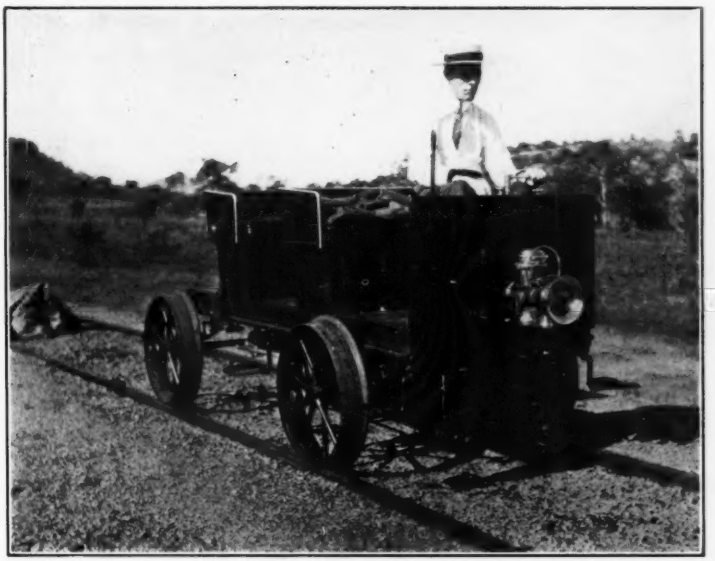
guese East Africa, a very important "feeder," indeed, to the Cape-Cairo trunk; and the line which begins at Mombasa, in British East Africa, and ends at Port Florence on Lake Victoria Nyanza, a matter of 584 miles. It is interesting to recall the fact that the first locomotive reached Port Florence on December 19, 1901. The first rail at the sea coast was laid on August 8, 1896, and the whole length of line was thus completed in four years and four and a half months. More important still from the point of view of the Cape-to-Cairo line is the railway which is now in process of construction from Lobito Bay, in Portuguese West Africa, to Katanga, in Belgian Central Africa, some 900 miles distant. It is a foregone conclusion that if ever this line gets to Katanga it will not be long before it joins the Cape-Cairo trunk, at a point yet to be determined but probably at Rhodesia Broken Hill, and thus directly connect with Beira in the east and Cape Town in the south. The concession to construct the line was granted to Mr. Robert Williams a couple of years ago, on the understanding that the

INTERIOR OF TRAIN-DE-LUXE, RHODESIA RAILWAYS.

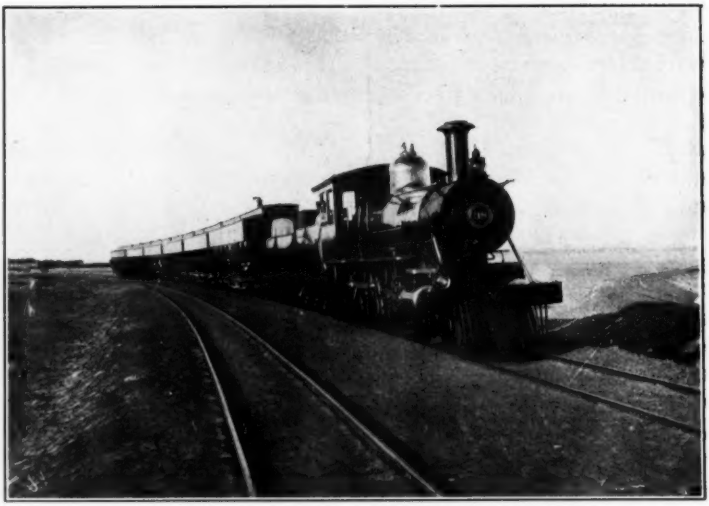
Portuguese Government obtained 10 per cent. of the issued shares and 5 per cent. of the net profits that may accrue, they themselves not guaranteeing a halfpenny. In return for this Mr. Williams is granted the exclusive mining rights over all minerals, supposed to be very abundant in this locality, found for a distance of 120 kilometers north and south of the rail route, which by-the-bye, is to be followed up by the construction of a telegraph line. The contract for the construction of the railway was secured by Messrs. Griffiths and Co., and the first section of the line, as far as Benguella, is now practically completed, and will be immediately followed up by the construction of another link to Monte Sahoa. I understand that the only engineering difficulties which present themselves on this route are to be found in the first portion thereof—up to Monte Sahoa. Black labour from the

negro republic of Liberia is being employed on this line and is said to be both cheap and good. Rubber and wax in large quantities are met with en route, whilst at Katanga there is an abundance of copper. Unquestionably this line, when completed, will have a very important bearing on the Cape-Cairo route; and as Lobito Bay is four or five days nearer England than Cape Town it is already seriously suggested that it may "some day" prove to be a very formidable rival indeed to the capital of the Cape Colony.

It would require more space than I have at my command to indicate, with anything like sufficiency of detail, the progress which has been made in the last five years with the numerous railway projects in various parts of Africa, some of which have a bearing on the great trunk line,—notably in the huge region under French sway in the western and northwestern portion of the continent, where a truly wonderful transformation is being effected, thanks chiefly to the advent of the iron horse. In the Congo Free State the railway is also slowly but surely advancing; and in Abyssinia it would appear that the jealousies of the various European Powers are not, after all, to be permitted to interfere with the progress of the much-debated railway. In



SIX-HORSE-POWER DE DION GASOLINE MOTOR CAR ON THE RHODESIA RAILWAYS.
Pauling & Co.



TRAIN ON SUDAN RAILWAY, WITH BALDWIN LOCOMOTIVE.

April last the Emperor Menelik told the representatives of the Powers, assembled at Addis Abeba, very plainly that their barren discussions were delaying the construction of the line and in view of the situation thus created he declared that if he received from the Powers no proposal placing the various international interests in agreement, he would himself undertake the construction of the railway without soliciting or accepting any co-operation.

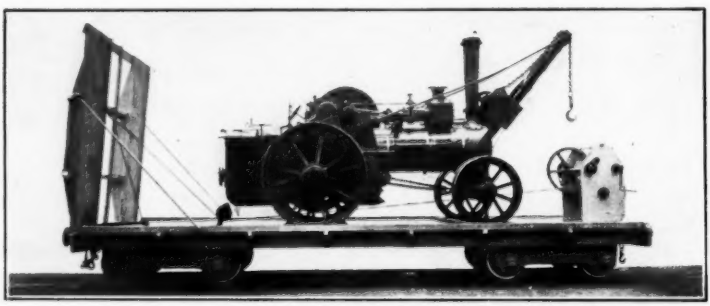
Small progress also remains to be chronicled in regard to the railway projects of German East Africa, of which so much was expected in connection with the Cape-to-Cairo scheme. It was originally proposed that the line commencing at Dar-es-Salaam should join the Cape-Cairo trunk at Ujiji, on the eastern side of Lake Tanganyika, taking in Mrogoro and Tabora en route. But things would appear to be in a bad way, financially speaking, in the German colony, and certainly but small sympathy with its railway aspirations has been shown in the Fatherland. Speaking in the Reichstag three years ago Dr. Stübel, Director of the Colonial Office, voiced the national feeling on the subject. He said it was proposed "for the present" to construct only the portion of the central railway connecting Dar-es-Salaam with Mrogoro. This section, he added, was designed to open up the highlands of German East Africa and was in no sense related to the Cape-to-Cairo scheme. Dr. Stübel further declared that the Cape-to-Cairo

TRAIN DE LUXE, OUTSIDE BULAWAYO STATION, RHODESIA.

Railway was a "phantom which would not bear comparison with other transcontinental railways such as those existing in America and Asia." The position to date seems to be that the line from Tanga on the coast to Lake Victoria Nyanza leads only 150 or 160 kilometers inland, whilst the projected line from Dar-es-Salaam to Ujiji is no more "forrader" than it was three or four years ago.

Coming to the northern section of the Cape-to-Cairo scheme, the extension southwards from Khartoum, the position remains much as it was four or five years ago. As a scheme pure and simple Lord Cromer apparently does not think very much of it, and it may be taken for granted that he will do nothing to directly further its interests. His opinion of the scheme was expressed very clearly in his official report on Egypt published in April, 1904, in which he stated that while he was not prepared to say that, from a purely engineering point of view, the execution of this plan—i. e., the establishment of a continuous railway communication from Cairo to Cape Town—"would be absolutely impossible," he was quite confident that, in view of the very great physical difficulties which would have to be encountered, the cost of constructing any such railway would be altogether out of proportion to its utility. Proceeding, Lord Cromer said:—"I am, however, given to understand that this project—if it was ever seriously entertained—has been abandoned, and that the idea of establishing

communication by rail and river between Cairo and Cape Town has been substituted in its place. This is altogether a different matter. A very difficult, if not the most difficult, part of the original project is thus abandoned, for it would be no longer necessary to construct a railway across vast marshes lying, roughly between the 5th and 10th parallels of north latitude. I cannot," said his lordship in conclusion, "speak with any authority as regards the difficulties which, in the execution of the revised project, might have to be encountered south of Gondokoro. All I need say is that the Egyptian and Sudanese part of the work is already accomplished. A regular tourist service by rail and river now runs from Cairo to Gondokoro." Obviously, when Lord Cromer penned these words he was more concerned with railway construction nearer home—in especial, with the extremely important sec-

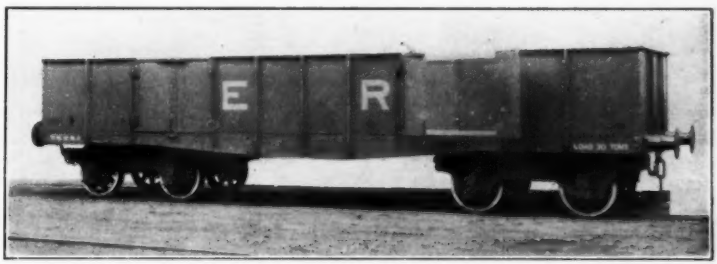


25-TON BOGIE CAR FOR TRANSPORTING STEAM PLOUGHING ENGINES.
Designed and built by the Leeds Force Co., Ltd., for the Egyptian Railway.

tion between Suakim and Berber, on the completion of which he has set his heart. All unconsciously, maybe, Lord Cromer has done not a little in helping materialise the late Mr. Rhodes's pet project. Lord Cromer, as was very truly pointed out the other day by a writer in the *Morning Post,* "has always looked towards the south," whilst "Mr. Rhodes always looked towards the north; the works of either, growing in the direction of either's gaze, are now coming together like the ends of a vast cantilever bridge." A year or so ago Sir Charles Metcalfe (who apparently reckoned without the brilliant administrator of Egyptian affairs) pointed out that if the Egyptian Government decided to build the proposed dam at Rosaire it was quite on the cards that the railway would be extended from Khartoum to Rosaire —which, in turn, would eventually be linked up with the Uganda railway. This accomplished, all that would be required to complete the great link from the north to the south would be a line of 600 miles

connecting the Uganda Railway with the Rhodesian terminus on the southern shore of Lake Tanganyika. And with all deference to Lord Cromer's inuendo that the Cape-Cairo railway would not be a commercial success it would be strange indeed, as the aforesaid writer is at pains to point out, "if a well-built railway, running through a fertile, elevated country in a continent almost two thousand miles broad and able to send out branch lines or feelers for traffic on either side, should not in the end, show a profit on its working."

So far—at its southern end at least—the Cape-Cairo railway has not been unproductive. I am of course referring to the Rhodesian section only. The official returns of the Rhodesia Railways, Limited,



30-TON BOGIE COAL CAR, EGYPTIAN STATE RAILWAY.
Constructed by the Leeds Force Co., Ltd.

for the year 1904-5 are not yet available, although they will doubtless be forthcoming soon. But the figures for the previous year are to hand, and these show that between April, 1903, and March, 1904, inclusive, the revenue was £573,286 16s. 8d., the expenditure £434,542 16s. 1d., the net revenue thus being £138,744 0s. 7d., and the percentage of expenditure to receipts 75.80. For the year ending 31st March, 1903, the revenue was £526,560, the expenditure £322,774, the net revenue £203,786 and the percentage of expenditure to receipts 61.30. When the depression under which South Africa is still labouring is removed and the waters of the Victoria Falls are "harnessed" for electrical production it is only reasonable to assume that the Rhodesian railways will be worked at considerably less cost and that the net revenue will be proportionately greater. At the present rate of progress the next five years should see some wonderful developments in the African railway world, and speaking personally I shall be very greatly surprised indeed if by that time the Cape-to-Cairo Railway is not within a stone's throw, as the saying is, of Lake Tanganyika.

THE DOCKYARDS AND SHIP-BUILDING PLANTS OF JAPAN.

By Chas. Albertson.

II. PRIVATE ESTABLISHMENTS.

One of the most important questions of the present day is to what extent Japan will be able not only to supply her own needs, but also to enter into active competition with Europe and America in the markets of Asia, in the near future. Mr. Albertson's article is therefore of peculiar interest as throwing much light on an industry which is of leading importance, both from a manufacturing and a commercial standpoint.—THE EDITORS.

IN a previous paper, after a broad discussion of industrial conditions in Japan, the general ship-building statistics were given, and the Government dockyards described. The present article takes up the private establishments for ship-building and repair work, and treats them in fuller detail.

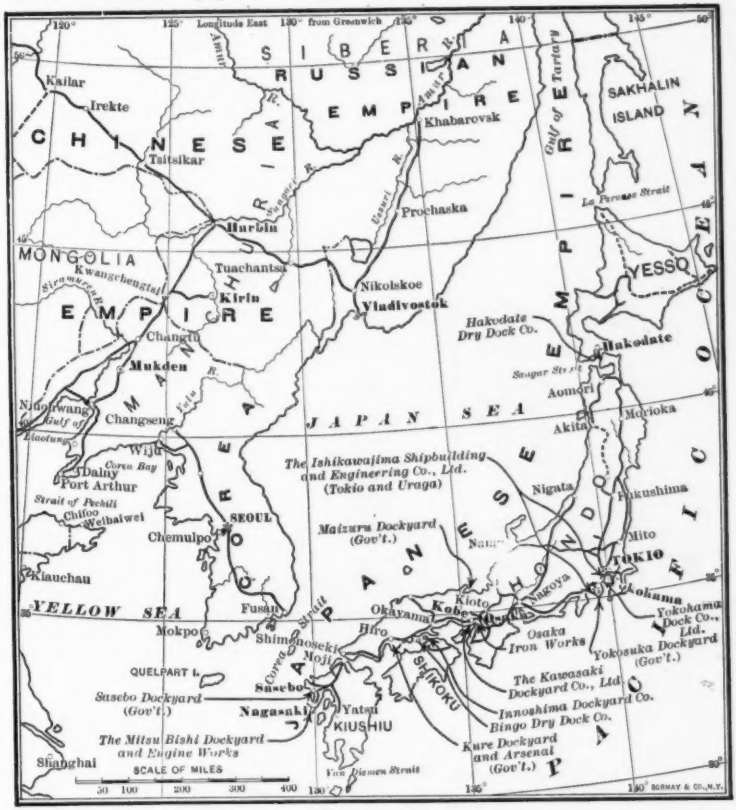
Mitsu Bishi Dockyard and Engine Works.—These works are for the most part on the northwestern shore of the harbor of Nagasaki and opposite the city of Nagasaki. The pretty harbor averages about one-half mile wide, is three or more miles long and is located at the southwestern extremity of Japan, which makes it a very convenient rendezvous and refitting station for all naval fleets in Far Eastern waters. The war vessels of half-a-dozen different nations are often at anchor here at one time. Most of the Pacific, European and other liners call at Nagasaki for coal, if for no other purpose.

In 1856 the Shogun built a small engine works at Akunoura, importing Dutch machinery and Dutch engineers to take charge of the plant. Akunoura is on the eastern end of the company's present premises and is to-day occupied by one of the best, if not the best, engine and boiler-building plants in all the East. The yards have a water front of one and one-half miles and the area occupied is about eighty acres. The original works, after serving the Shogun Government in doing repair work on very small vessels for about ten years, came into the possession of the government of His Imperial Japanese Majesty, the present Mikado, at which time they were greatly improved.

What is now the No. 1 dry-dock, since lengthened, was then built at Tategami, located at the western end of the premises, and a patent slip at Kosuge on the south side of the harbor, owned by a British

merchant, was purchased. In 1884 the entire plant was sold to Barons Y. Iwasaki and H. Iwasaki, who are the proprietors of the Mitsu Bishi Company, which, besides owning this great concern, controls other large industrial enterprises in Japan.

These ship-building and engine works are then the oldest and most extensive in Japan. They have in use three dry-docks and one

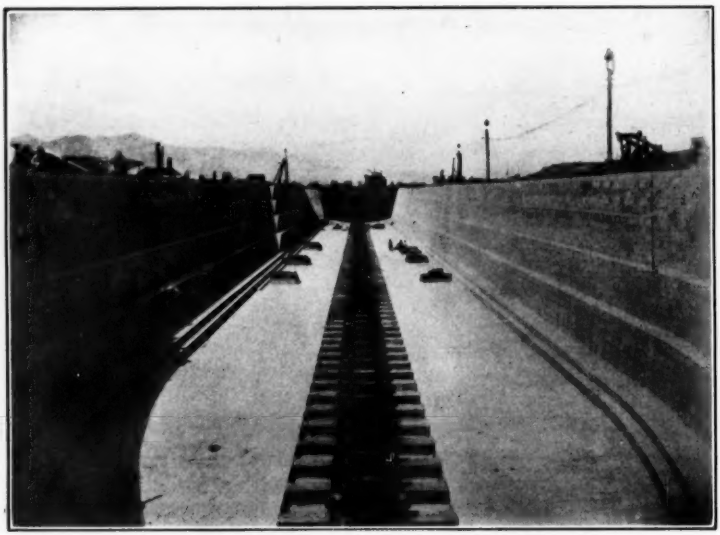


JAPAN AND NEIGHBORING COUNTRIES, SHOWING PARTICULARLY THE LOCATION OF THE JAPANESE SHIPYARDS.

patent marine slip. The big dock can accommodate the largest iron-clads and merchant ships which now float the Pacific, and since these are as large as any in the world, the immense size of the new dry-dock is readily apparent. The company is prepared to undertake any kind of marine work whatsoever, including the heaviest, since it has

lately installed the very largest and latest types of necessary machinery, has exceptional docking facilities, and is greatly extending the area covered by permanent buildings.

The tonnage of vessels launched from 1885 to 1894, inclusive, would scarcely average 250 tons per year, although the company did a very large docking and repair business. Since then, however, the ship-building end of the business has rapidly increased and the works can now easily turn out 20,000 tons yearly. In 1895 about 2,500 tons were launched; in 1898 about 8,000 tons; in 1899 about 4,000 tons; in 1900 about 11,300 tons; in 1901 about 7,200 tons; in 1902 about



GRAVING DOCK OF KAWASAKI DOCKYARD CO., LTD.
Length, 426 ft.; width at top, 64 ft.; depth, 24 ft.

15,875 tons; and in 1903 about 13,100 tons. From 1885 to 1897, inclusive, the indicated horse power of engines built in the shops would not average more than 600 yearly. Since then, up to 1903, the yearly horse powers follow: In 1898, 4,225 horse power; 1899, 3,200 horse power; 1900, 13,500 horse power; 1901, 6,240 horse power; 1902, 13,340 horse power; 1903, 11,463 horse power.

There are on the office and yard staff about fifty men, including six foreigners. The total number of workmen employed from 1884 to 1893 started at 766 and ran up to 1,200. At the end of 1897 the

number had increased to 3,800, and then remained stationary until the end of 1900. At the end of 1903 there were 5,658 men on the pay roll. These tables show very decidedly the increase in capacity and business since about the time of the war with China.

In 1898 the first 6,000-ton steamer was launched, since which time this yard has built six others just as large, six of about 2,500 tons, six of about 1,600 tons, besides a half dozen smaller ones. They have built for the Imperial Japanese Navy one 120-ton torpedo boat and two each of 82 tons, the Government furnishing the materials. They have also constructed two dredges of 500 gross tons each for the Wakamatsu Harbor Works, and a large number of small craft of various types from 100 to 300 tons. The company is proud of the twin-screw steamship "Aki Maru," of 6,443 gross tons and 5,448 indicated horse power, now belonging to the Nippon Yusen Kaisha and ordinarily in service on the American line running to Seattle; also of the little steam yacht "Hatsukaze" of 80 tons gross and 200 indicated horse power, built for the use of the Crown Prince and launched in 1902. Japanese art has figured largely in the trimmings and furnishings of both these ships and the result is unique as well as highly satisfactory.

The dimensions of the three dry-docks, all of which are faced with granite and built in solid rock are as follows:

	Length on keel blocks.	Top entrance width.	Bottom entrance width.	Depth of water on blocks at spring tide.
No. 1 Dock.	510 feet	89 feet	77 feet	26 feet 6 inches
No. 2 Dock.	350 feet	66 feet	53 feet	24 feet
No. 3 Dock.	714 feet	96 feet 7 inches	88 feet 7 inches	34 feet 6 inches

The patent marine slip owned by the company has a length of rail of 750 feet, width between rails of 30 feet, and it is capable of taking vessels weighing up to 1,000 tons.

The company is prepared to undertake extensive salvage operations, having built especially for this purpose the steamer "Oura Maru" which is 186 feet long, 29 feet beam, 16 feet depth, and 712 tons gross. She is fitted with four centrifugal pumps, three pulsometers, and one special pump, and is capable of handling 2,000 tons of water per hour, and is equipped with a large electric light plant so that salvage operations may be carried on both night and day.

In order to obtain enough satisfactory men, the company conducts a school which has been in operation for five years. This school is carried on in a handsome two-story brick building built for this especial purpose. They teach five classes of boys, in all about 250.

About fifty boys enter each year, besides 100 apprentices who are given lessons in the morning before going to work. In March, 1904, twenty-two boys graduated and entered the different departments as apprentices for a term of five years. As showing the attitude of large works to the outside public, it is interesting to note that this school is free to anyone who cares to enter.

The company has built a hospital where it maintains a corps of physicians who treat the employees of the company free of expense. They have accommodations for fifty patients at one time. The company also owns its own water supply. That the company is liberal in its treatment of employees is shown by the further fact that since 1897 they have had in operation a combined pension and insurance system. To this fund each employee makes a monthly payment, while the owners contribute an equal amount. The benefits range from 50 to 2,500 yen, according to the standing or position of the employee, and are given to the families of those who are either injured or die at the works. Those who retire from old age receive a pension. A savings bank system is also in operation. Each employee who so desires deposits one yen on each pay day, on which the company pays a liberal rate of interest. When the principal and interest reach 300 yen the company then adds 50 yen to the amount and another account is opened.

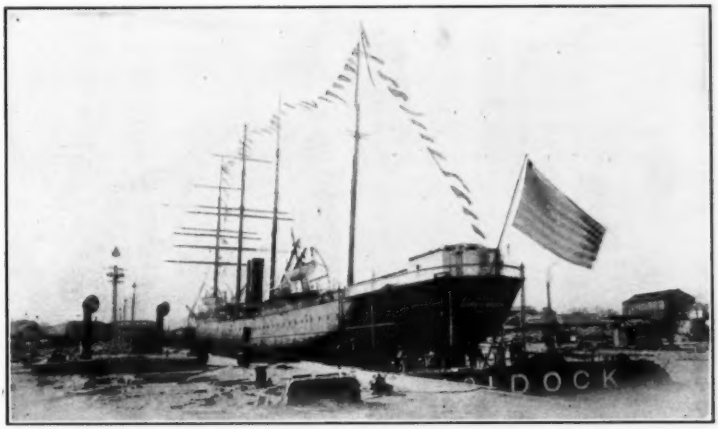
On the premises the company has erected a club house for the use of its officials and foremen. It is fitted with billiard tables and various games. Lunch and light refreshments are served at any time. A small library and reading room is supplied with reading matter, consisting mostly of engineering and naval works, text books and current technical journals. Upon the beautiful hillsides back of the works and overlooking the harbor there are about twenty official residences for such of the high class employees as care to occupy them. It will thus be seen that the company takes an interest in about everything that pertains to the welfare of its workmen.

Kawasaki Dockyard Company, Limited.—This company has extensive grounds and a lengthy water front on the west side of Kobe harbor. The city of Kobe is located near the entrance to the celebrated inland sea, on the northwest shore of Osaka Bay, and only a little south of the center of Japan's eastern coast line.

As showing the type of men who now enter ship-building and other industrial works in Japan, it is worthy of mention here to note that the president of the company, Mr. K. Matsukata, is a son of Ex-Premier Count Matsukata, the father of Japan's present financial

system and who is still one of the Mikado's trusted advisers. To find a man of this type engaged in business enterprise only goes to show the immense change that has taken place in Japan within the last forty years. Previous to that time the better class Japanese would have nothing to do with business and the merchants were not looked upon with favor. At the present time the change is complete and business is an honorable profession with men of all rank. The coming of the higher class Japanese into business has brought in the much needed higher ideals as to commercial methods and honesty.

In order to keep posted on the best designs, tools and manner of working in Europe and America, the officials send every year in reg-

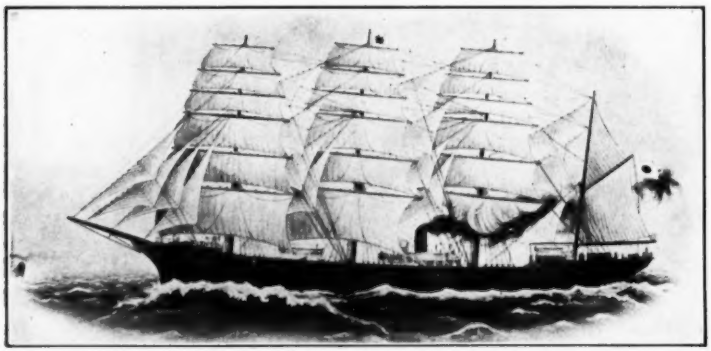


STEAMSHIP "CITY OF PEKIN" IN LARGE DOCK OF KAWASAKI DOCKYARD CO., LTD.

ular rotation one of their engineers to study what is being done. Besides this the management occasionally sends some of the executive members to study up that side of the business. The company is a thorough believer in the ability of the Japanese to do things and hence does not employ foreigners in any capacity. Like all the other large dock companies, it buys only the best material, and the management and engineers insist on turning out good work.

While Kobe is not the home port of any large steamship lines, yet all the steamers, both from Europe and America, including cargo and passenger steamers, make Kobe a port of call. This port has therefore the largest tonnage of any harbor in Japan and naturally the shipping interests are very large. This makes an ideal location for dockyard companies.

The Kawasaki Company is the largest in operation in Kobe at the present time, next to the largest in Japan, and is engaged in ship-building, repairing and general engineering work. The Japanese Government, being paternal in its rule, early started to establish various industries, and ship-building was one of those thus helped. As these industries developed and no longer needed governmental care, they were turned over to private companies to operate, and so it came about that this establishment was sold to Mr. Shozo Kawasaki some time in 1886, after having been started by the government in a small way during the seventies. In 1896 the present stock company was organized, taking over the whole works and capitalizing them at 2,000,000 yen, which was fully paid up. Since then



TRAINING SHIP "TAISEI MARU," BUILT BY THE KAWASAKI DOCKYARD CO., LTD.
300 feet long; 4,300 tons. Used by Nautical College of Tokyo.

they have issued, mostly taken by the original stockholders, another 2,000,000 yen, of which only part has been paid up. Although nominally a registered stock company, it is practically a close corporation, since the majority of the stock is held by a few influential men. The company regularly pays a dividend of 12 per cent. on the stock, and has issued bonds at two different times, each issue being 1,000,000 yen, bearing 9 per cent. and 7 per cent. interest.

The company has nine ship-building berths and the necessary machinery for laying down and building vessels of various lengths up to 600 feet and 7,000 tons gross. It also has a splendid dry-dock, described below, and two patent slips, the larger of which is 600 feet long on the rail and will take vessels up to 280 feet long and about 2,000 tons gross, while the smaller one is 400 feet long on the rail and will take vessels up to 180 feet in length. The present and

proposed buildings, of which there are an ample number for all purposes, are some of them of large size, and all the buildings now being erected are either of brick or skeleton steel frame work with galvanized roofing and sides. They are being located and arranged so they can readily be extended as the business increases.

Outside of its regular ship-building, docking and repair work, the Kawasaki Company has made boilers of various sizes and types, including eight Miyabara water-tube boilers for H. I. J. M.'s cruiser "Hashidate," marine and land engines, direct-connected centrifugal pumps, engines, tanks, steel pipe, etc. It also has in operation a special department for the manufacture of shells for the small guns of the imperial defence. It has a good sized salvage steamer built by itself, fitted with powerful electrically driven pumps, diving apparatus, derricks, and all other necessary gear. On the grounds is a small dispensary fitted with first aid appliances, while a regular physician is always within call.

The management is very progressive and the company was the first in Japan to build vessels for export. It points with pride to the pioneer export ship, the steamship "Liu Hsing," a lighthouse and buoy tender, built and engined complete for the Imperial Chinese Maritime Customs at Shanghai. This vessel is fitted with twin screws, triple-expansion engines of 1,300 indicated horse power, electric light and all other modern appliances. The gross tonnage is 750 and the speed thirteen knots. She is 185 feet long, and was completed in June, 1902. The Kawasaki Company has also built a small river gunboat for the Chinese government, a lighthouse tender, which will carry a couple of small guns, for the Korean government, and a steam launch for the Siamese government.

The growth of the works will be shown from the fact that in 1898 the tonnage of the ships launched was about 1,000, having engines of 1,200 indicated horse power, while there were employed at the works about 1,800 men. In 1902, 8,500 tons were launched, with engines of 11,000 indicated horse power, and the number of employees was about 3,500. In all they have built about fifty vessels, the largest to date being about 2,300 tons gross.

The power used throughout the works is almost entirely electrical. The larger machines throughout the works are run by individual motors, while the small ones are run in groups. The management is considering the installation of an 800-kilowatt steam turbine unit. The company has also in use what is probably the most extensive pneumatic outfit in the empire. The pneumatic plant and

the various tools were imported from America, where the management sent an engineer to be thoroughly instructed in their use.

They also have a very powerful hydraulic plant for flanging, joggling and forging, which was imported from England. This was the first dockyard in the empire to install a cast-steel plant, and for some time past they have been using cast steel wherever necessity called for light weight combined with strength, such as frames for engines in torpedo boats, and have had very good success in this line of work.

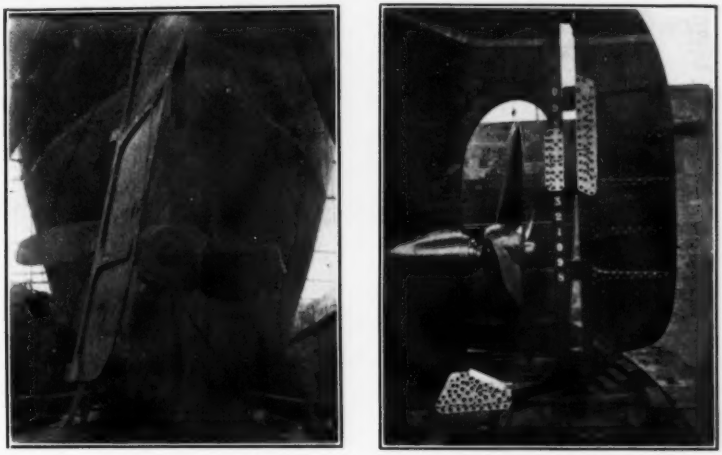
To a foreigner an interesting event, which throws a side-light on Japanese labor, takes place when the works close at night and the men file out through narrow passage-ways where they are searched by inspectors before being permitted to leave the premises. This, of course, is to prevent the workmen carrying off any small articles of value which they could readily sell to junk shops.

The shipping conditions in Kobe harbor began to demand a dry-dock in the early nineties. The Kawasaki Dockyard people therefore prepared to meet this demand, and upon making an examination of the strata underlying their property, found that they would have a very difficult piece of engineering work in order to successfully build a dry-dock. Test borings showed that under the top layer of sand there was a layer of silt some 25 feet thick, beneath which were other layers, mostly sand, all evenly charged with water and evidently connected with the sea. The opinion was freely expressed among the foreign engineers living in the vicinity that the dock could never be built at the site selected. The dock was however officially opened in June, 1902, having been about five and one-half years in building. Since then it has been occupied almost continually and remains as when built as tight as a drum and as dry as a bone.

The dock complete with pumping outfit cost about $850,000. The American, German, Austrian, British and other governments have had their war vessels in this dock, which is also patronized by all the European, Australian, American and Japanese steamship lines which call at Kobe. Its dimensions are as follows: Length, caisson to toe of head wall, 426 feet; length on floor, 392 feet; width of entrance at top, 64 feet; width of entrance at bottom, 52 feet; depth of sill below high water, spring tide, 24 feet.

As illustrative of the manner in which the Imperial Government makes use of the industries in the empire which may be of assistance to it, the following is of interest: All the larger warships of the Imperial Japanese Navy have been imported, principally from England, and until lately most all of the smaller vessels were also built

abroad. Torpedo boats and torpedo boat destroyers were often sent for repairs to the larger and best equipped of the private dockyard companies, which in this manner became more or less familiar with the construction of these little craft. Later on torpedo boats and torpedo boat destroyers were ordered from abroad, but were shipped knocked down to Japan, and sent with the erecting drawings to a few of the private dockyard companies, including the Kawasaki, for erection. The companies thus had the benefit of the experience obtained; first in repairing; second, in erecting the small vessels, and the third and final step was the building of these small craft themselves. This two or three of the dockyards are now doing and some

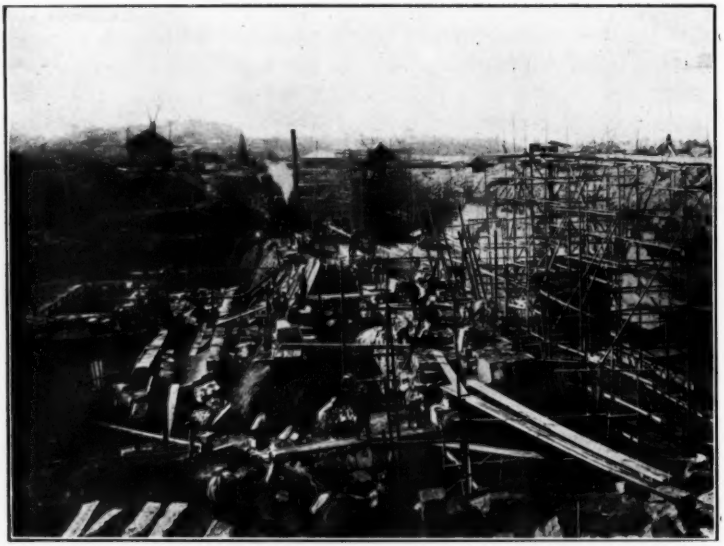


STEAMSHIP "KHALIF" IN YARD OF YOKOHAMA DOCK CO., LTD.
On the left she is shown with stern frame and rudder damaged in a typhoon, and on the right, with temporary repairs, with which she steamed full speed to Cardiff, Wales.

of the vessels so built have seen service in the present war. By this method Japan is gradually absorbing the knowledge of other nations and taking into her own hands work of all kinds as fast as she is able to equip herself to undertake it.

Yokohama Dock Company, Limited.—Yokohama is situated upon the western shore of Tokyo Bay and in order to protect its shipping the government has made a good harbor by building an extensive breakwater. Within this breakwater, and upon the city's shore front, is located the Yokohama Dock Company's property, which is therefore accessible in all kinds of weather.

Before there were any graving docks in Yokohama, the old Mitsu



NO. 2 DOCK AND PUMP HOUSE OF YOKOHAMA DOCK CO., LTD., IN COURSE OF CONSTRUCTION, 1896.

Bishi Steamship Company owned a small repair works there. When the Mitsu Bishi Company was absorbed by the Nippon Yusen Kaisha in 1885, the latter of course took over the repair works, but desiring to confine their attention to their growing shipping business only, they sold the repair shops to the Yokohama Dock Company, Limited, in 1896. This yard differs from some of the others in Japan in that it was not started, and has not been assisted by the government.

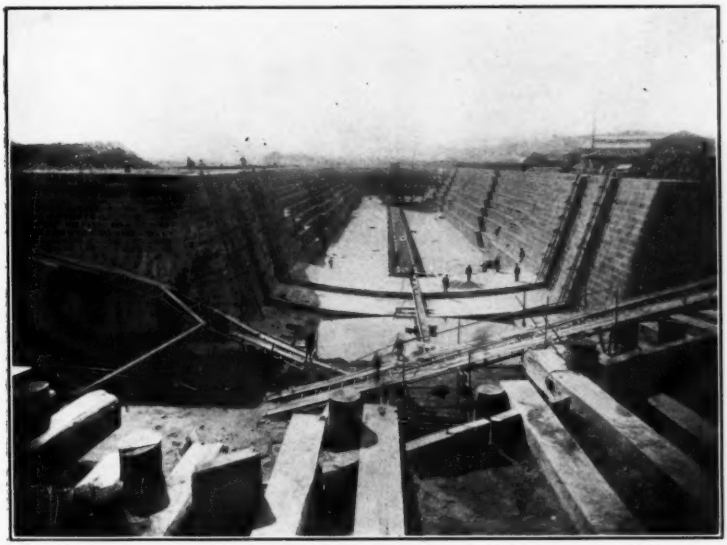
Although this company is engaged largely in doing repair work, yet it builds small towing boats, yachts and launches, lighters, land and marine boilers and engines, steel frame buildings, etc. In 1903 the company erected steel frame work amounting to 400 tons, and generally finds this class of work profitable. In 1904 there were on the premises nineteen buildings and eleven sheds, eleven of which were brick, one steel frame, and the rest stone.

Yokohama is either the terminus or home port of almost all of the many lines running from Europe and Australia via Southern Asia to China and Japan. It is also the beginning and end of all the great Nippon Yusen Kaisha's schedules with the exception of the American line. All the big and little Transpacific steamers call at Yokohama as well, so it was an excellent location for much needed docks.

The present company started operations in 1896. Its small dock was opened in 1897 and the large dock in 1899. The works were started with the idea of docking and doing repairs only and this has been largely continued to the present time. They are the result of a desire, on the part of some of the shareholders of the Nippon Yusen Kaisha and of some influential Yokohama men, to have ample facilities for docking vessels in Yokohama. Previous to the opening of these docks the most available place for repairs in this neighborhood was at the government docks at Yokosuka, but these were available only by obtaining special permission and in case of extreme necessity.

The area of the works is 37,624 tsubo, or 1,354,464 square feet. The water front has a length of 3,104 feet. In the dredged passage or basin in front of the docks there is a depth of 36 feet at high water, but in the harbor outside the basin it is not quite so deep, although this is now being deepened. The larger part of these works was built on reclaimed land with the understanding that the property was to belong to the company when the reclaiming was properly done.

In all the company has on its pay roll about 1,000 employees, of which a fair number are apprentice boys. Usually the different grades



LARGE DOCK OF YOKOHAMA DOCK CO., LTD., COMPLETED 1899.

PART OF YARD OF YOKOHAMA DOCK CO., LTD.

of men are trained in the works, although occasionally some are obtained from the smaller yards with which Japan abounds. Probably 15 per cent. of the present help has come from other works, and a less proportion than this drifts away either to start business for themselves or to work in other shops. At this yard, as in all Japanese yards, it is difficult to secure in a hurry any exceptionally large increase in employees, although a floating number up to about 15 per cent. of the present number is usually readily secured.

Here, as elsewhere, there are no regularly organized labor unions, but the old time customs, which are very powerful and sometimes deeply felt, have to be regarded very carefully. Ordinarily, however, the workmen are fairly just in their requests and are not troublesome. They feel that they belong to the company and to its officers. In fact one might almost say they feel that a part of the company belongs to them. Really they seem to take pride in being a part of the works, which increases with the length of their service, and this feeling is not without reason, because the men are kindly treated and seldom discharged even when work gets scarce. When once discharged there is considerable difficulty in getting them back again. Here, as everywhere and in every condition in Japan, the old feeling of master and servant still remains to an extent so much greater than in our own country that it is hardly conceivable by us.

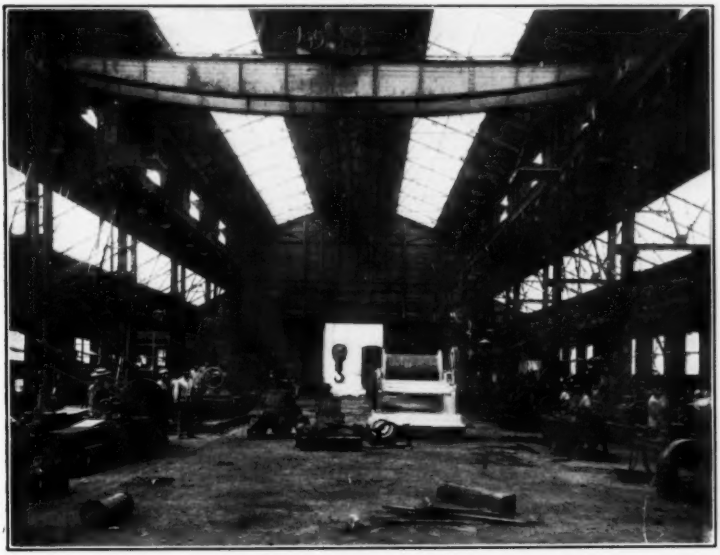
The men show an adaptability in changing from one kind of work to another, otherwise on repair work the company would not be so successful. Those, however, who work on machine tools are kept there

permanently. It is the established policy of the company to substitute labor-saving machines for hand work wherever possible, since it considers these both quicker and cheaper than the best labor obtainable, the price of which is rapidly rising.

A floating derrick of thirty-five tons capacity is in use along the water front, while a system of light railways facilitates transportation of materials among the buildings. A branch of the Imperial Government Railway runs into the yards and is connected with a system of tracks reaching all the main buildings. The buildings thus reached are served by a six-ton traveling crane.

A wet dock without gates is now in process of construction for enabling deep-draft vessels to be moored at the works. This will be built on property now owned by the company and will be 500 feet long, 160 feet wide and thirty feet deep at low water, and will take about two years to complete. The company has in operation two dry-docks and one small marine slip, which is used mainly for tugs, launches and other small craft. The larger dry-dock has an inside length of 514 feet, and the other, of 375 feet.

The largest vessels docked have been the "Inaba Maru" and



MACHINE AND FITTING SHOP OF YOKOHAMA DOCK CO., LTD.

Showing hauling winch for slipway.

other European liners of the Nippon Yusen Kaisha, these being rated at about 6,200 tons gross, and having a length of 449 feet, beam 49 feet 9 inches, and depth 30 feet, 6 inches.

Ishikawajima Shipbuilding & Engineering Co., Limited.—This company has in Tokyo a wooden graving dock, and besides shipbuilding and docking has a considerable trade outside the regular marine line of work. It has never built any large ships, but all told has launched something like 125 vessels, mostly of wood. 13,000 tons gross will cover the output. In 1902 the company amalgamated with the Uraga Dock Co., Ltd., and the combined works are now in position to build ships of large size. The Uraga property is near the entrance of Tokyo Bay and is conveniently located for the large ships making Yokohama or the smaller ones making Tokyo. There are two docks at Uraga, one having a length of 497 feet and a depth of 26 feet, and the other a length of 471 feet and a depth of 24 feet 6 inches. Either dock can be emptied in three hours. Warships belonging to the governments of the United States, Germany and Austria have been docked and repaired here. These yards have several shipbuilding berths and all the necesssary machinery for the building of large ships, besides the equipment necessary in the docking and repairing of ships.

Osaka Iron Works.—These works are located near the mouth of the Aji Kawa (Aji River) which flows through Osaka and empties into Osaka Bay through the new Osaka harbor works. The business has been gradually increased until now the works occupy about 20 acres of land, with a water front of about 2,000 feet.

Up to the present time the yards have turned out about 200 ships, a little less than two-thirds of which are very small wooden vessels, the balance being steel. In this number are included several light-draft steamers for freight and passenger service on the short and shallow Japanese rivers. Under the Subsidy Act and since 1900 the company has built, engined and launched seven steel steamships having a total of 8,000 tons gross and 7,000 horse power.

There is one 250-foot dry-dock in operation, two more are projected, and the company possesses the usual equipment for docking and ship-building, together with that required for such work as usually comes to an iron works. At the present time it is impossible to turn out large vessels, since the river is only 14 feet deep, but when the harbor works are completed the river will be dredged and the works will be equipped to build larger ships.

The company does a great deal of outside work, including cast-iron

pipes for water-works, bridge and steel frame work, complete concrete making plants, and bucket dredges for the rivers and harbors of Japan having a capacity of from 100 to 400 tons per hour.

One of the peculiar features of common labor among the Japanese is the don't-care fashion in which they look upon the necessity of regular attendance at work. The Osaka Iron Works for instance can secure the daily presence of only about 90 per cent. of their employees. The other 10 per cent. think they are sick or imagine some friend is unwell, or they are off on a lark by themselves or a picnic with their families, or they are taking a comfortable loaf or perhaps have earned so much money that they of necessity must see it all spent, or they just simply and plainly want a day or two off. At any rate fully 10 per cent. are absent daily, and the idea that they are affecting adversely their employer's interests never once enters their heads. They have constitutionally and absolutely no regard for regular attendance. Such a condition would not be tolerated for an instant in this country but in Japan it cannot be helped.

Hakodate Dry-Dock Co.—This is the northernmost of the Japanese dock companies and is located at Hakodate on the southern shore of the Island of Hokkido. The works started first with a patent marine slip having rails 520 feet long, and capable of lifting vessels up to 1,400 tons gross. With the increased shipping interests in that section these facilities were inadequate and the company has recently finished a new granite dry-dock 534 feet long at the top, 82 feet wide at the top, and 72 feet wide at the bottom, with 30 feet of water on the sill at spring tide. This is not a shipbuilding company. The equipment owned is sufficient for light repairs only.

Innoshima Dry-Dock Co.—This company builds wooden junks and does ordinary repair work on medium size steamers. It is located on an island near the center of the Inland Sea and has two dry-docks cut from the solid rock. The larger dock is 357 feet long on the bottom, 50 feet wide at the top, and 44 feet wide at the bottom, with 20 feet of water on the sill at spring tide. The other dock is used for light draft inter-island trading vessels which are usually docked two at a time, and is 300 feet long.

BRASS-FOUNDRY RECORDS AND COSTS.

By H. Deighton.

THE subject of brass-foundry records and costs, though of great importance to engineers and manufacturers, is one to which comparatively little attention is usually given by them. When attempts are made to improve matters, too theoretical a view is often taken, leading to the employment of elaborate and complicated forms, which result in dissatisfaction and discouragement. Records connected with a foundry should be as few and simple as possible. Their chief objects are:—

To ensure that all metals and supplies are properly accounted for.

To regulate the production.

To obtain accurate costs of castings made.

Too often a brass foundry is untidy and uninviting, and nobody seems to take much interest in it. Everything appears in confusion. Valuable metal is scattered around covered with dust. Consistent with such conditions, the probabilities are that verbal orders prevail, and that the foreman makes whatever castings he considers are necessary or likely to be required in the near future. If an investigation were made of the quantities of rough and finished castings in stock from each pattern number, it would show excessive quantities of certain kinds on hand and few, if any, of others. An estimated cost price is taken periodically, after which castings are "said to cost" so many cents per pound, and very likely the fact is overlooked that several different alloys are made in which the value of the metal alone may vary several cents per pound.

But here and there are brass foundries kept as orderly and almost as clean as the average machine shop. From such as these only can accurate and valuable records be expected.

Instances of brass and other metals being stolen from foundries are of such frequent occurrence, that it is no unusual thing for a manufacturer to consider this as an inevitable misfortune, and to add a percentage to his costs to provide for such a contingency. However, in an orderly and systematic foundry, under a careful foreman, whose records are properly kept and supervised, there should be little danger of loss from this source.

Though the foundry and machine shop are so closely allied, the methods of obtaining costs in the former differ very considerably from those pursued in the latter. In a machine shop, the exact amount of material can usually be charged up to a job immediately it is assigned, and before any work is done on it. In a foundry, however, the amount of metal for a lot of castings cannot be accurately determined till they have been made, cleaned, and weighed; which, in fact, would seem to be the only practicable way of obtaining this information. It is much more difficult to record the labor on each specific order in a foundry than in a machine shop. In many foundries the recording of this by means of time slips is not feasible. There are several different methods used in distributing the departmental burden or indirect expense in a machine shop, some of which are very arbitrary. In a foundry, however, these expenses can usually be quite equitably distributed at a rate per pound on the weight of the castings.

Perhaps the most common way followed in arriving at costs in a brass foundry—which, though very simple, is quite unscientific, and generally very inaccurate—is for the foreman to weigh and report daily the quantity of metal, fuel, and other supplies used, and also the quantity of castings produced. At the end of the month the former are summarized, priced, and extended, and added to the amount of the payroll, together with all other current operating expenses for the month. This sum divided by the number of pounds of castings produced during the month, gives the average cost per pound.

In certain cases an average price so obtained might answer the purpose. In connection with a brass foundry attached to a machine shop building similar kinds of machines containing several castings of various sizes, it would be sufficiently correct in the aggregate and not misleading; but in getting the price for any specific part, it might be altogether misleading. In the case of castings made indiscriminately for job or repair work, or for sale, such a method of obtaining costs might soon prove to be very disastrous.

Castings ought not to be made on verbal orders. There should be written production orders issued from the office for everything.

The opinion seems to prevail generally that it is hardly practicable to record the time of core makers and moulders by means of time slips. While this method does certainly fail in many cases, it is only impracticable under adverse conditions. Where the foundry is not large, or where the number of different kinds of patterns in use is limited, there should not ordinarily be much difficulty about this, provided

A separate production order must be issued for each pattern

PRODUCTION ORDER NO.----------

To the foreman of Brass-Foundry

Please make castings as specified below.

On completion deliver to Store-house.

Charge time of core-makers and molders to above Order No.

Issued----------**190**---- ----------

For Superintendent

QUANTITY	DESCRIPTION	PATTERN NO.

----------**190**----.

Received from the Brass-Foundry

cleaned castings as above weighing in all-------**lbs.**

Storekeeper

The Engineering Magazine

PRODUCTION ORDER. ORIGINAL IS 4¾ INCHES WIDE.

the co-operation of a careful foreman be obtained. Even in large foundries, it would often pay to employ a shop clerk to look after this and other clerical work. Where the piece-work system is in force, some such records must necessarily be taken, either by means of time slips or memorandum books. One of the greatest difficulties encountered is that several different patterns are often made up in the

same flask, necessitating the division of the time. In such cases, unless this is correctly distributed, the records will be of very doubtful value.

In foundries where the time of core makers and moulders cannot be recorded by means of time slips, in order to obtain specific costs recourse will have to be made to estimates. The different patterns can be divided up under "core" and "coreless" castings, and these further subdivided into say about a dozen grades known as grade "A," grade "B," &c; the grade to which each different pattern is assigned being determined by the quantity of cores per day which a core maker is ordinarily able to make, and the number of pounds of castings per day which a moulder can put up.

Metals should not be scattered around the foundry, especially such as tin and copper, which are so valuable. The stores keeper should have control of all metals and supplies (the former being kept under lock and key), and requisitions be given to him each day by the foundry foreman for whatever he draws out of store.

Gates, sprues, and other scrap metal (including castings that on account of obvious defects are condemned on the spot) should not be allowed to accumulate in the foundry, but should be melted up again as fast as possible, in preference to obtaining further metal from the store house. Care must be taken, however, that the foundry operations are not charged again with such. However, it frequently happens that a foundry foreman will report to the office the weight of these along with the weight of the new metal, thus causing himself to be charged twice, and as a consequence destroying to a great extent the value of his records for the month.

After castings have been cleaned, they should be delivered into the store house, and a receipt obtained for the exact weight, which should be charged to stores and credited to the operations of the foundry. In making up specific cost sheets, the weight of the metal used can be obtained from this receipt; it is necessary, however, to divide the weight up according to the composition of the alloy, and to add a small percentage for loss in melting due to oxidation and other causes.

The "prime cost" of a lot of castings consists of:—

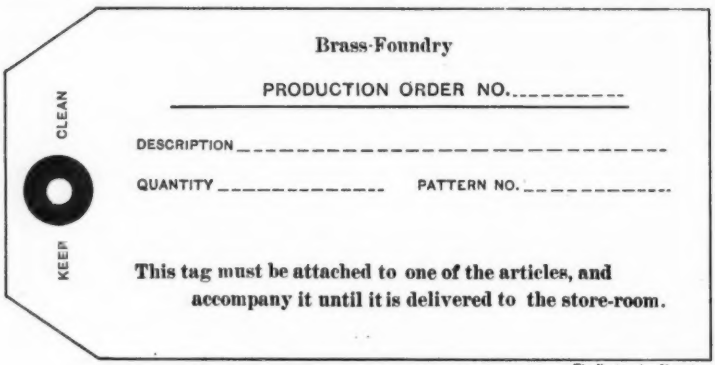
The core-makers' time.
The moulders' time.
The metal used.

The "cost of production" is obtained by adding to this its share of the indirect departmental expense at a rate per pound on the weight

of the castings, which is the ratio which these expenses for a given period bear to the number of pounds of cleaned castings produced. These expenses consist of:—

Supervision, general labor, cleaning castings.
Crucibles, fuel, and other supplies consumed.
Cost of power used.
Current repairs, and other operating expenses.
Depreciation of the plant and equipment.
Proportion of general factory expenses.

Illustrations are now given of the forms used in connection with the system of a small brass foundry employing less than twenty hands. This system is very simple, and everything works quite smoothly, owing to having an intelligent foreman in charge of a su-


Brass-Foundry
PRODUCTION ORDER NO.----------
CLEAN
DESCRIPTION----------
QUANTITY---------- PATTERN NO.----------
KEEP
This tag must be attached to one of the articles, and accompany it until it is delivered to the store-room.
The Engineering Magazine

COURSE TAG. ORIGINAL IS 4¾ INCHES WIDE.

perior grade of men, and also the fact that the nature of the work is such that (except in rare cases) each production order can be completed by one delivery of castings to the store house.

There are five forms in use, the first four of which only are handled in the foundry, the other (the cost sheet) being kept in the office. The forms are:—Production Order, Course Tag, Stores Requisition, Daily Time Slip, and Cost Sheet.

The production orders are consecutively numbered and issued from a carbon pad in the superintendent's office, a separate one being used for each different pattern number. At the foot of this order will be noticed a receipt, which the stores keeper signs, for the quantity and weight of cleaned castings delivered to him by the foundry. Each production order issued is accompanied by a course tag, giving

Brass-Foundry REQUISITION FOR STORES

----------190----

QUANTITY AND DESCRIPTION	RATE	AMOUNT		
LBS. INGOT COPPER				
" " TIN				
" SCRAP COPPER				
" SPELTER				
" LEAD				
" COAL				
CRUCIBLES				
MOULDING SAND				

Above stores received by

The Engineering Magazine

REQUISITION FOR STORES. ORIGINAL IS 4½ INCHES WIDE.

also the production-order number, quantity, general description of article, and pattern number; its purpose being for the instruction and guidance of the core makers and moulders and for general identification of the work.

The foundry foreman hands the stores keeper each day a stores requisition for everything he obtains from the store. These are priced and extended in the office and summarized at the end of the month,

their total forming the basis of an entry in the general books as a credit to stores account and a debit to the brass-foundry operations.

The daily time slips made out by the core makers and moulders are O. K.'d by the foreman, and delivered to the office every morning. Where occasionally the patterns for two or more different production orders are made up in the same flask, the moulders divide up their time. At first the foreman attended to these cases himself, but he soon trained the men to distribute their own time. No time slips are necessary for labor in the foundry other than core making and moulding, such being an indirect departmental expense.

BRASS FOUNDRY DAILY TIME SLIP ----------190---

WORKMAN NO.------- NAME----------

DESCRIPTION OF WORK	PRODUCTION ORDER NO.	HOURS	RATE	AMOUNT

O. K. ---------- FOREMAN

The Engineering Magazine

DAILY TIME SLIP. ORIGINAL IS 5½ INCHES WIDE.

A cost sheet is kept in the office with each specific production order, on which are segregated the different charges against it. To this the time of the core makers and moulders is charged from the daily time slips. The weight of metals used is obtained from the storeskeeper's receipt at foot of the production order, being the weight of the cleaned castings delivered to the store house. This has, however, to be divided up according to the different metals composing it, as, for instance, in the case of a lot of bronze castings 80 and 20 mixture weighing 265 pounds, the composition of which is 212 pounds copper and 53 pounds tin. The metal in this is charged to the cost sheet as 218.36 pounds copper, 54.59 pounds tin, which includes an increase of 3 per

COST SHEET FOR PRODUCTION ORDER NO._____

ISSUED_____190____

DESCRIPTION _____

_____PATTERN NO._____

PARTICULARS	RATE	AMOUNT		TOTAL	
COREMAKERS' TIME:-					
MOLDERS' TIME:-					
METALS USED:-					
COPPER LBS.					
TIN LBS.					
SPELTER LBS.					
LEAD LBS.					
ADD AMOUNT OF INDIRECT EXPENSE					
@ 100 CENTS PER LB. ON LBS.					

_____CASTINGS WEIGHING IN ALL _____LBS.

COMPLETED_____190____

The Engineering Magazine

COST SHEET. REDUCED SIZE.

cent. to provide for loss in melting. Before closing the cost sheet, there is added to this "prime cost" its proportion of the indirect expense as a rate per pound on the weight of the castings. While this rate is changed occasionally, it fluctuates in the neighborhood of two cents per pound.

In the office, the cost sheets closed during each month are summarized, the total forming the basis of an entry in the general books as a debit to stores account and a credit to the brass foundry operations.

The production order in use here acts both as a production order and also as a receipt for castings delivered to the stores keeper; this is rendered practicable by conditions which permit each order to be completed by one delivery to the store house; in the few rare cases where this cannot be done, the production orders are recalled and closed, and new ones—bearing new numbers—issued for the balance.

At the end of each month a comparative general monthly manufacturing account is made up showing the operations of the foundry. This is credited with the number of pounds and value (as per summary of closed cost sheets) of castings delivered into the store house, and charged with the quantity and value of metals, fuel, crucibles, and other supplies drawn out of the store house, also with the direct and indirect labor as per the pay roll, and all other indirect expense. An adjustment has of course to be made here of the difference in quantity and value between any small inventory of metals and supplies, etc., that may be on hand in the foundry at the beginning and end of each month, which is, however, only trivial. This monthly account shows:—

Whether the specific costs appear correct.
The percentage of metal lost in melting.
The quantity and cost of fuel per 100 pounds of castings produced.
The cost of crucibles and other supplies per 100 pounds of castings produced, etc.

Being printed and ruled in tabular form so as to last for twelve months, and provided with columns for percentages as well as for quantities and amounts, the effects of any variations from month to month are clearly shown up here, so that their causes can be promptly investigated.

THE MECHANICAL FEATURES OF THE INTERNATIONAL EXPOSITION AT LIÉGE.

By Léon Ramakers.

Each exposition, whether its scope be wide or narrow, is necessarily influenced by its environment, and so we find that the Liége Exposition, held in the heart of an active industrial region, is especially strong in its mechanical, mining and metallurgical features, which show the most recent advances and best modern practice of European engineers, an account of which, therefore, will be found of real interest and value.—THE EDITORS.

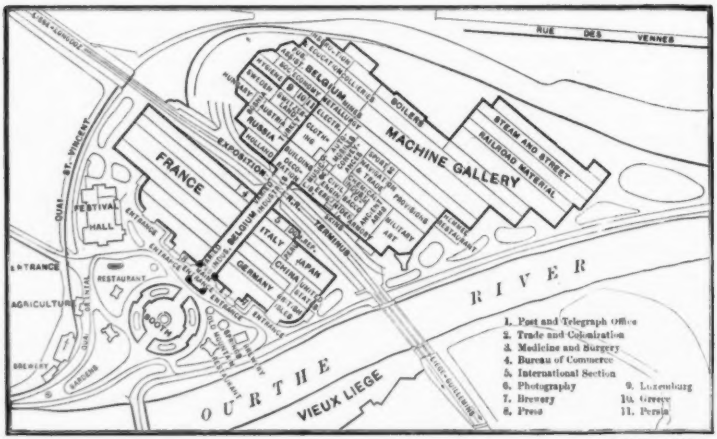
BELGIUM, although one of the smallest countries of Europe, is in the front rank industrially, and with her active population, the densest in the world, her great coal and iron trade and her many manufactures she possesses an importance entirely disproportionate to her superficial area. After the close of the Napoleonic wars, she was for a time linked with Holland under the same government, but a racial and religious incompatibility between the Belgians and the Hollanders led to a severance of their union in 1830. Since then each country has gone about its business in its own way, and both have progressed and prospered.

In order to celebrate the seventy-fifth anniversary of their independence the Belgians decided to have an international exposition this year and to hold it at Liége, the capital of the Walloon district. This city was chosen because it is practically the industrial metropolis of the country. Liége and the surrounding territory have been for centuries one of the world's greatest centers of industrial activity, being particularly celebrated for the manufacture of arms and weapons, and at the present day the coal mines, the iron and steel works and the manufacturing establishments of all kinds combine to give this region an international fame. Liége is also an important railroad center and lies within a few hours' journey of London, Paris and Rhenish Westphalia, besides all of Belgium and Holland, so that it has a very large number of possible visitors within easy reach, a most important consideration for an exposition city, and it has convenient access to many celebrated pleasure resorts, from Ostend to the Forest of Arden.

The exposition, which has been open during the past summer, is situated in the southeastern suburbs of Liége, just at the confluence of the Ourthe River with the Meuse. The largest and most important section of the exposition is on the right bank of the Ourthe, and com-

prises the Halls of Manufactures and of Commerce and some other buildings, which contain manufacturing, engineering and machinery exhibits. The fine arts buidings and the building for the display of laces, in the manufacture of which Belgium occupies such a leading position, are in a park on an island between the rivers; the agricultural exhibits and the amusement section of the fair are on the left bank of the Meuse, and a historical show, "Old Liége," is situated on the point of land where the rivers join. The total area of the exposition grounds is about one hundred and fifty acres.

Thirty-two foreign nations are represented at the Liége Exposition, most of which have special sections in the main buildings, while



BORMAY & CO.' N.Y.

PLAN OF MAIN BUILDINGS, LIÉGE EXPOSITION.

The art palaces, the lace building, and other structures, are on an island in the rivers and on the opposite bank of the Meuse River. The top of the plan is toward the east.

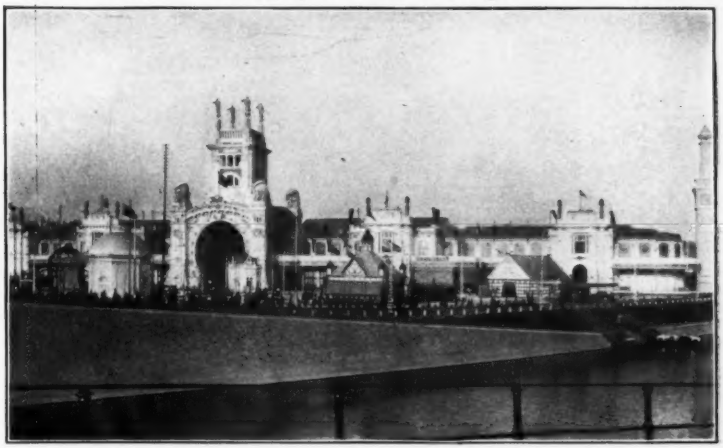
others, such as Canada, Norway, Morocco, Servia, Bulgaria and Montenegro, have their own pavilions in the park on the island above mentioned. The most interesting foreign exhibits are those of France, Germany and Canada, while the other nations make a showing in general accord with the extent of their territory, their degree of civilization and their economic importance, with a few exceptions.

The main buildings, that is to say the Halls of Manufactures and of Commerce, cover an area of about one hundred and twenty thousand square yards and are intersected near their middle by the line of the Northern Belgian Railway. Their principal façade, constructed entirely of wood and staff, is flanked by two towers, one of

which is used for wireless telegraphy, and is characterized by a monumental entrance in "modern style," having an imposing archway with square columns at the four corners and surmounted by a square tower crowned with statues.

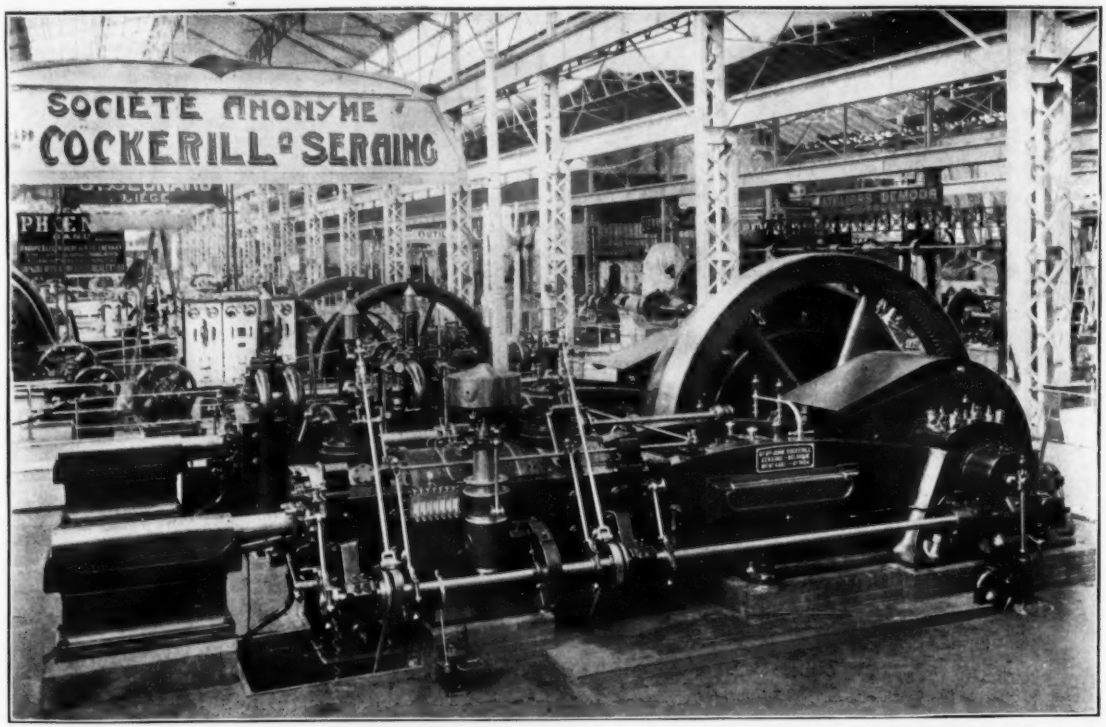
The main buildings have saw-tooth roofs, with zinc and glass roofing. The steel roof trusses are supported by latticed and sectional-steel columns, which rest on concrete piers, and the steel work is designed so that it can be used for other purposes at the close of the exposition.

The machinery halls, which form the rear portion of the main group of buildings, are constructed with bays alternating in span between forty-nine and eighty-two feet and, together with the boiler

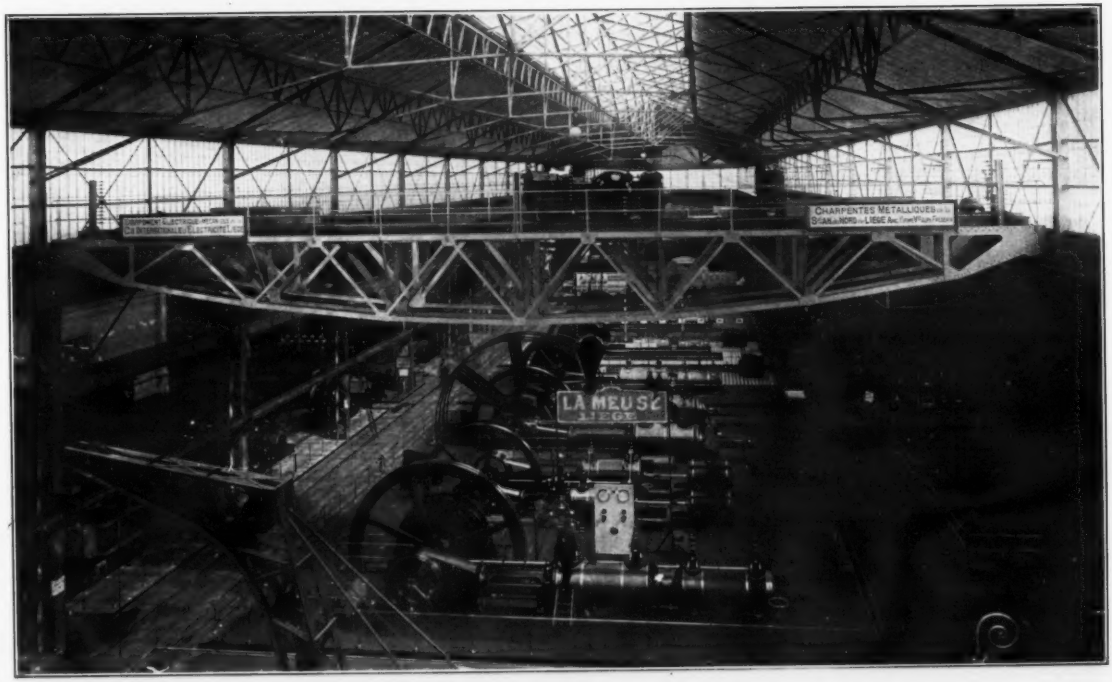


PRINCIPAL ENTRANCE OF THE MAIN BUILDINGS, LIÉGE EXPOSITION.

house, gas producers and railway exhibits, cover an area of over thirty-five thousand square yards, of which Belgium occupies more than half, France a sixth and Germany a little less. Besides this there are mechanical, electrical and mining and metallurgical sections covering an area of about six thousand square yards in the Hall of Manufactures. The machinery building is served by eight traveling cranes, four of which have spans of eighty-two feet and capacities of thirty tons each, the other four being of smaller dimensions. The larger cranes were built by the Société Cockerill, the Société le Titan Anversois, the Compagnie Internationale d'Electricité of Liége, and the Société Stuckenholz, and the others by the Société Gilain, the Société Cockerill, M. Gustin fils and the Société Westinghouse.



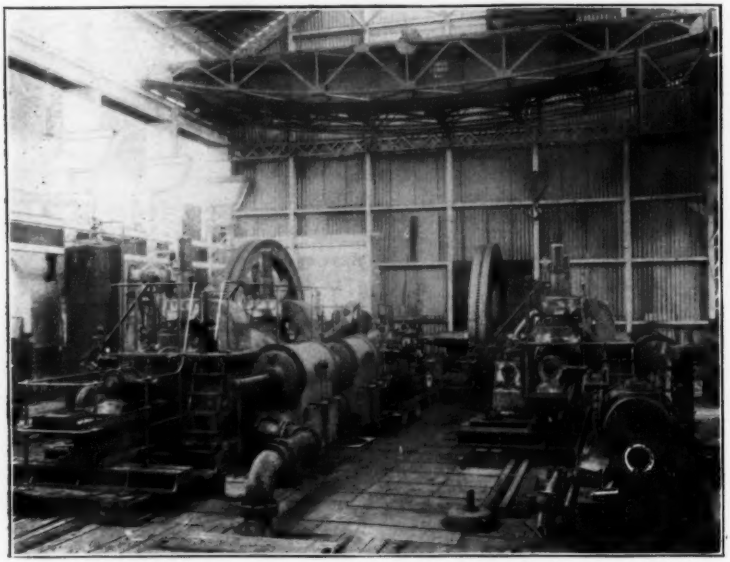
500-HORSE-POWER, FOUR-CYCLE, DOUBLE-ACTING COKE-OVEN-GAS ENGINE.
Société Anonyme John Cockerill, of Seraing.



ONE OF THE WIDE BAYS OF THE MACHINERY BUILDING.

The large traveling crane, with a capacity of 30 tons and a span of 82 feet, was equipped electrically by the Compagnie Internationale d'Electricité, of Liége.

Nineteen boilers, of eight different types, are placed under cover at the rear of the Belgian machinery section. Close by are three gas producers. The water required for the boilers and for other purposes at the exposition is taken from the Ourthe River at a point above the city and distributed by a new system of mains and pipes. Steam is furnished to the engines at a pressure of 135 pounds per square inch. The regular electric current supply for lighting and power is distributed by a three-wire, direct-current system, with 440 volts between the outer conductors. This current is generated by three sets, of 750 horse-power apiece, each composed of a reciprocating steam engine



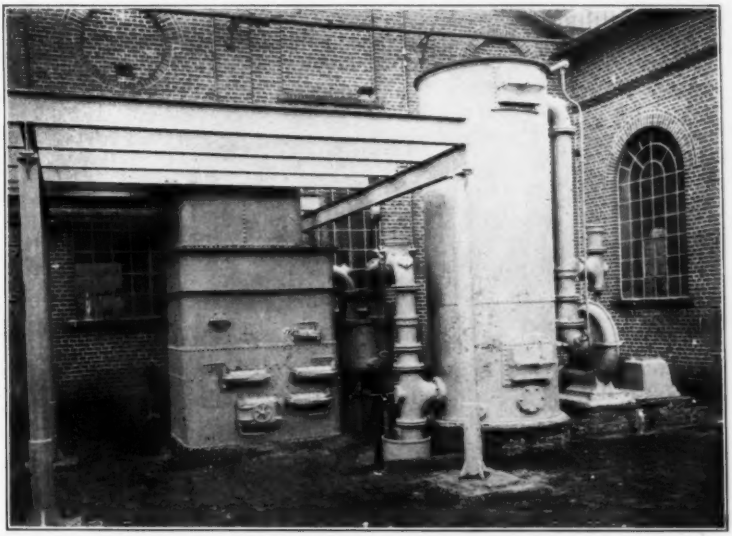
600-HORSE-POWER, TWO-CYCLE, DOUBLE-ACTING, BLAST-FURNACE-GAS ENGINE.
Société de St. Léonard, of Liége.

and a dynamo, and built, respectively, by Carels, by Van den Kerchhove and by Preud'homme-Prion. The French section generates its own current and distributes it at 3,000 volts alternating and at 120 or 150 volts direct. The city furnishes gas for lighting and power, and the internal combusion engines also use producer gas and gasoline. There is no central condensing plant, each exhibitor fitting up his own condenser to suit his requirements.

As the Liége district is the seat of such thriving coal and iron industries, it is but natural that mining and metallurgy and their allied

interests should play a leading part at the exposition, and there is, in fact, an excellent display of mining machinery and metallurgical appliances.

The well-known Cockerill Works, of Seraing, close by Liége, have one of the largest and most striking exhibits. They were among the pioneers in the construction of large gas engines for operation with blast furnace gas, and their engines are now in very extensive use. One of their most recent types is exhibited, a 1,200 horse power, four-cycle, double-acting, horizontal tandem engine, which is run at 100 revolutions per minute, and whose two cylinders have each a

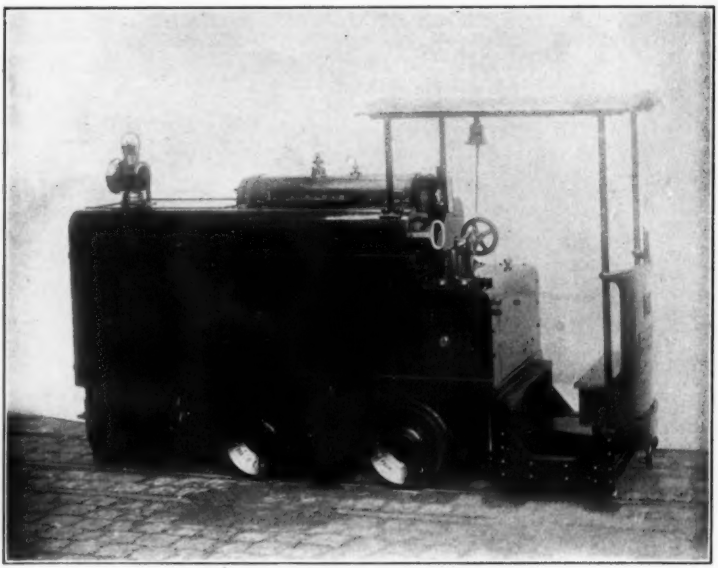


250-HORSE-POWER GAS PRODUCER USING LIGNITE BRIQUETTES.
Deutz Gasmotoren Fabrik, Cologne-Deutz.

diameter of thirty-nine and three-eighths inches, with a stroke of forty-three and five-sixths inches. This engine is to be used for the direct driving of a rolling mill at their own works. Another gas engine which they show is a 500-horse-power four-cycle, double-acting, twin-cylinder one, for coke-oven gas fuel. This also is to be used at the Seraing works, in the electric power plant. A second blast-furnace gas engine is of 150 horse power; this is a high-speed vertical engine, running at 250 revolutions per minute. The latter two engines are operated at the exposition with illuminating gas and drive electric generators, whose current serves to turn over, for exhibition

purposes, a Cockerill 10,000-horse-power, triple-expansion, reversible steam engine, with six cylinders, for use at the Seraing rolling mills.

Another Cockerill exhibit is a solid forged steel propeller shaft 169 feet 8 inches long, with a weight of forty tons, and a diameter tapering from 13.9 inches to 11.8 inches. For comparison it may be stated that the Krupp steel shaft at the Düsseldorf Exposition, in 1902, had a length of 147 feet, 8 inches, and a diameter of 21.3 inches, and was, moreover, hollow. The Cockerill Works also show a powerful six-coupled compound locomotive, with Walschaert valve gear, designed for hauling loads of 350 tons at 63 miles an hour, compound



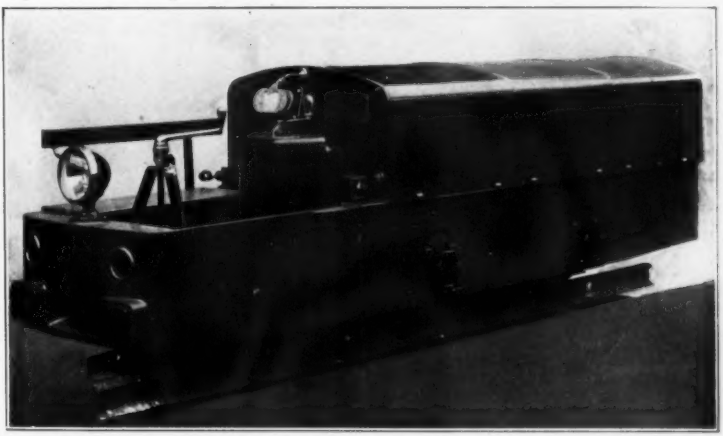
EIGHT-HORSE-POWER BENZINE MINE LOCOMOTIVE.
Deutz Gasmotoren Fabrik, Cologne-Deutz.

steam engines and air compressors, crank shafts, locomotive wheels, models of blast furnaces, coal mines and coke ovens, and a number of other objects which make a powerful impression of the magnitude and variety of their productions.

Gas engines are also shown by other companies, the exhibit of the Société Saint Léonard of Liége, which includes a 600-horse-power, two-cycle, double-acting engine for blast-furnace gas, and several smaller ones of the Koerting type being noteworthy. These engines,

while at the exposition, are supplied with gas by a producer shown by Fichet and Heurtey, of Paris, of the double-combustion form, which is suited for burning cheap fuels.

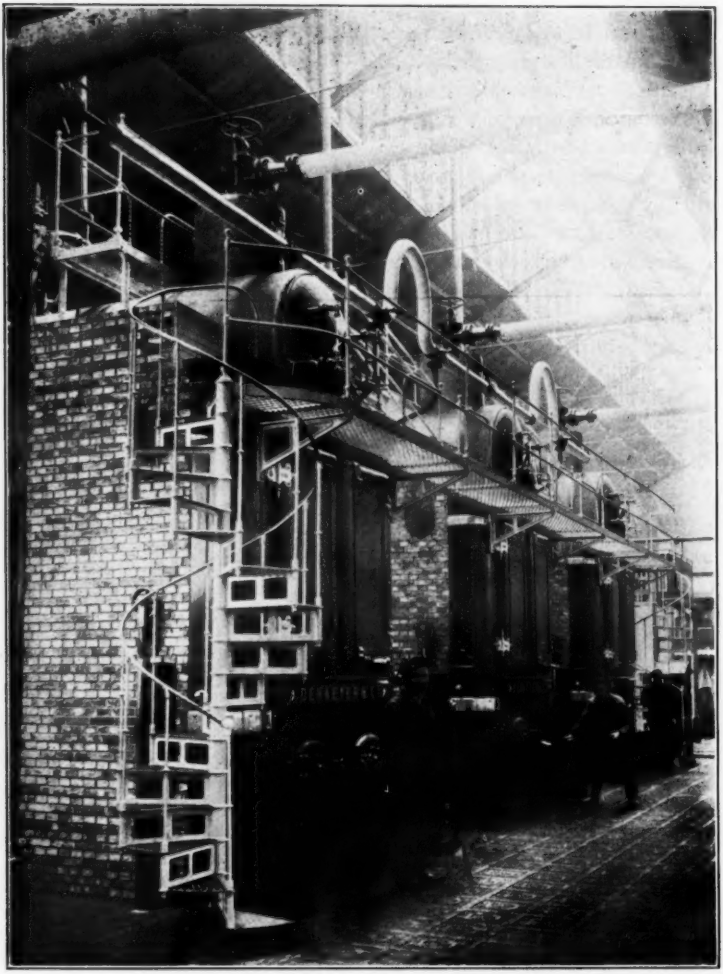
Another gas producer, of a novel type, is exhibited by the Deutz Gas Engine Works, of Cologne-Deutz, the fuel for which is briquettes of lignite, or brown coal. In this exhibit there are also gas engines, one of 250-horse-power, and one of 50-horse-power, supplied with fuel by this producer, as well as other internal-combusion motors and an anthracite suction gas producer, and an 8-horse-power mine locomotive with a benzine motor. A mine locomotive of a different kind is shown by the Société Electricité et Hydraulique, of Charleroi. This is an electric locomotive, equipped with storage batteries, and driven by two 6-horse-power motors.



ELECTRIC-STORAGE-BATTERY MINE LOCOMOTIVE.
Société Electricité et Hydraulique, of Charleroi, Belgium.

Large winding engines, steam driven, are in the stands of the J. J. Gilain Company, of Tirlemont, Belgium, and the Meuse Works of Liége. The Gilain engine can lift a load of ten tons from a depth of 5,000 feet at a mean speed of 46 feet per second, while the Meuse engine has a somewhat smaller capacity, but both are fitted very completely with safety appliances. The Meuse Works also exhibit a gasoline portable engine, which can drive a dynamo or do other work, and is a very handy machine.

Among the traveling cranes which command the different bays of the Machinery Building, the most interesting, perhaps, is that built by the J. J. Gilain Company, as it is the only one equipped with alter-



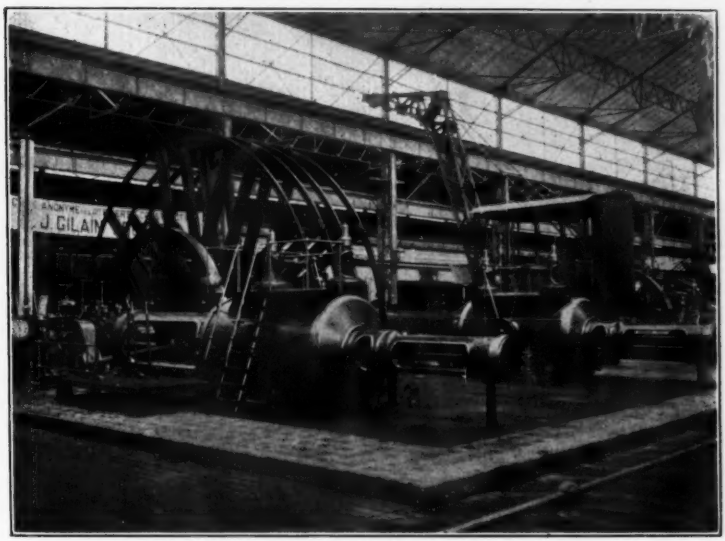
WATER-TUBE BOILERS AND STEAM SUPERHEATERS.
Vve L. De Naeyer & Cie., of Willebroeck, Belgium.

nating-current motors. It has a span of forty-six feet eight inches and a capacity of ten tons, and its speeds per minute are: hoisting, twenty feet; trolley travel, ninety-eight feet; bridge travel, 262 feet. One of the largest cranes in the building and one which was of great service in erecting the machinery, is that of the Compagnie Internationale

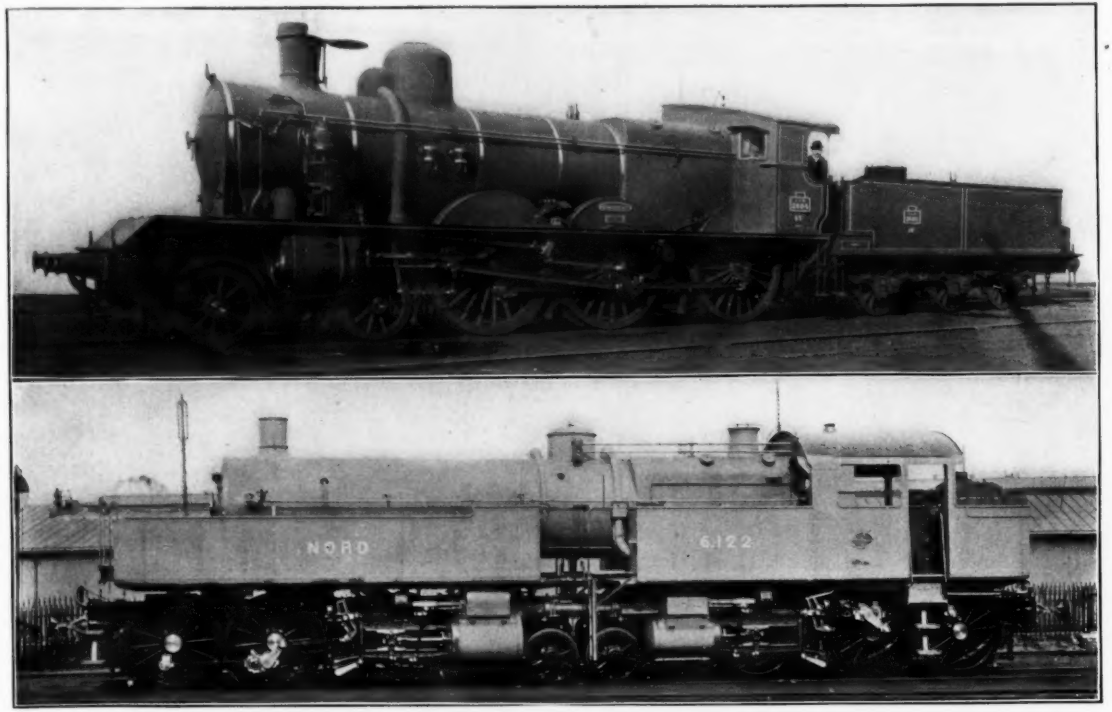
d'Electricité, of Liége, with a span of eighty-two feet, and having two hooks, one with a capacity of thirty tons and a hosting speed of eight feet per minute, and the other of six tons capacity and a speed of thirty-six feet. Its trolley travel is 171 feet, and the bridge travel, 164 feet per minute.

Locomotives are well represented by some fine engines, shown, among others, by the Northern Railway of France, the Paris-Lyons-Mediterranean Railway, the Cockerill Works, and the Meuse Works. The Northern Railway exhibit is an articulated compound locomotive, with four cylinders, and twelve driving wheels, in two independent sets of six. It has also two pony trucks, in the middle, making sixteen wheels in all, and has a length of over 40 feet. It can haul 1000 tons up a 1.2 per cent. grade at a speed of nearly fourteen miles an hour, and on the level at from forty-seven to fifty miles. The Paris-Lyons-Mediterranean locomotive is one of twenty recently ordered of Schneider & Cie., of Creusot, and is designed for high-speed work. It is a four-cylinder, compound engine, and has six drivers and a four-wheel bogie truck forward.

The Deutsch-Oesterreichische Mannesmannröhren Werke, of Düsseldorf, exhibit a very interesting locomotive boiler, equipped with a



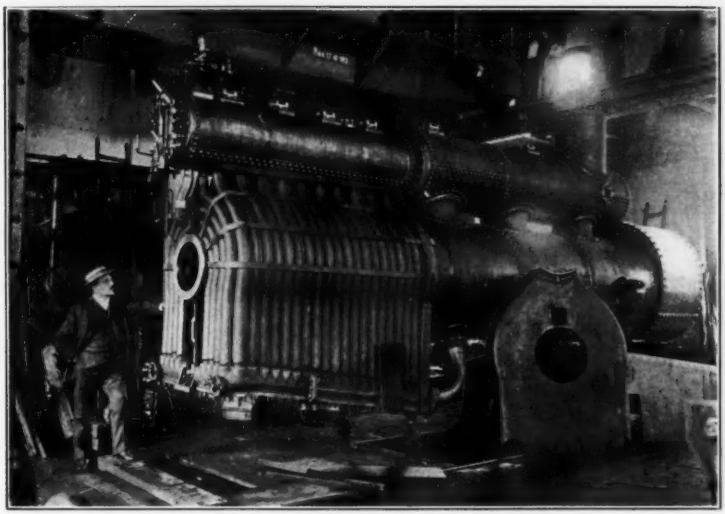
DOUBLE HORIZONTAL WINDING ENGINE.
Société Anonyme J. J. Gilain, Tirlemont, Belgium.



NEW FRENCH PASSENGER AND FREIGHT LOCOMOTIVES.

The upper one is a six-coupled, high-speed engine, built by Schneider & Cie., Creusot, and exhibited by the Paris-Lyons-Mediterranean Railway. The lower one is an articulated locomotive shown by the Northern Railway of France.

Brotan water-tube fire-box. The defects inherent in the usual types of fire-box are here remedied radically by forming the sides and rear of Mannesmann seamless steel tubes, arranged with an interval of less than one-tenth of an inch between them. Their lower ends are rolled into a cast-steel pipe, and their upper ends into the rear portion of a second boiler lying above the main fire-tube boiler and projecting toward the rear. This second boiler carries the steam dome and is connected to the fire-tube boiler by means of three necks. From the fire-box, the gases of combustion pass forward through the tube plate into the fire tubes of the main boiler. This fire-box, which is covered with a sheet-metal jacket that can be removed piecewise, makes the



"BROTAN" WATER-TUBE FIRE-BOX FOR LOCOMOTIVES.
Deutsch–Oesterreichische Mannesmannröhren Werke, Düsseldorf.

boiler a combined fire-tube and water-tube one, and, in addition to increasing its strength and permitting the use of higher steam pressures, enables steam to be generated more quickly and economically.

Among the boilers which form a working exhibit at Liége, may be mentioned two Galloway boilers and three water-tube boilers, the latter provided with feed-water heaters and steam superheaters, built by Vve. L. De Naeyer & Cie., of Willebroeck, Belgium; one from the Jacques Piedboeuf Works, of Jupille-lez-Liége, made in two parts, the lower having furnace flues and the upper fire-tubes, an arrangement providing a large heating surface in small space; a Niclausse

water-tube boiler; and a Babcock & Wilcox boiler, remarkable for its large size and its sectional construction throughout in forged steel.

There are many more mechanical and engineering exhibits of great interest, which the limitations of space prevent describing, such as the well-known Green economizer; mine pumps shown by Otto Schwade & Company, of Erfurt, Germany; Corliss compound steam engines built by the Phœnix Company, of Ghent; steam engines for driving electric generators, from the Breda Works, in Holland, and the Van den Kerchhove Works at Ghent; a rotary engine which can

GASOLINE PORTABLE ENGINE.
Ateliers de Construction de la Meuse, of Liége.

be operated with gas, steam, oil and other mediums, shown by the Fortunesco Motor Co., of Cologne; and a great variety of others.

Turning to another side of the exposition, the art palaces, the lace building and the other structures in the park on the island contain a great deal that is pleasing and of interest, and are very ornamental in themselves. An amusement section is also provided, and the exposition is expected to prove financially profitable, besides being, as it is, a great success from the industrial, engineering and artistic standpoints.

MODERN POWER-PLANT DESIGN AND ECONOMICS.

By Franz Koester.

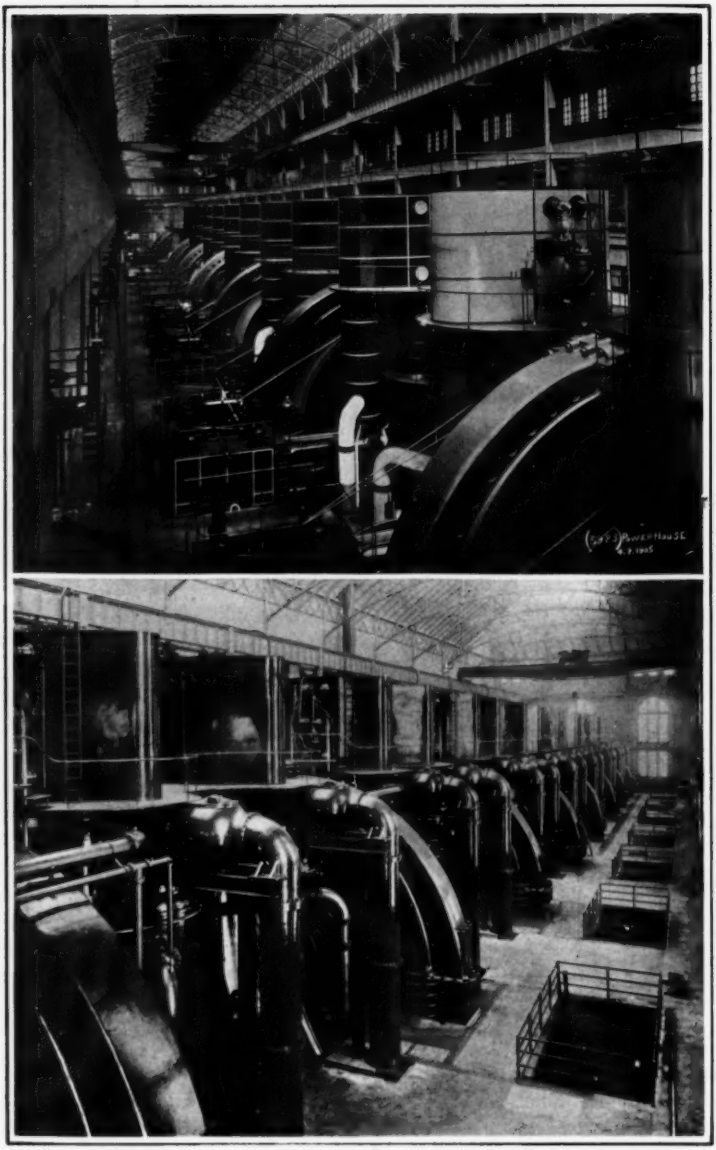
In the preceding portions of Mr. Koester's paper, which appeared in the August and September issues of this magazine, he discussed first the general aspects of the design of large power stations, and afterwards the coal handling machinery, the boilers and steam piping and other features of the steam generating plant. In the present section he takes up the prime movers and compares the steam turbine with the reciprocating engine, and also treats of the condensers and other auxiliaries. The concluding portion will be devoted to the electric features of the plant.—THE EDITORS.

VIII. STEAM ENGINES.

THE time has passed when a stationary engine requires 20 pounds of steam to produce one horse power per hour. Modern engines—meaning good engines of up-to-date design—must furnish one horse power per hour with not more than 14 to 15 pounds. This is often considered good practice by American engineers. In the beginning of these articles I stated* that the continental engineer demands a horse power per hour with about 10 pounds. The turbine, commercially adopted in Europe some ten years earlier than in the United States, would probably have outstripped the reciprocating engine had the latter not been improved. Now as both engine and turbine, here as well as abroad, show a comparatively even steam consumption, it will be some time before the latter takes the lead. As long as steam is used for generating power, the reciprocating engine will never entirely disappear, although we have already sufficient proof that the engine may disappear as the large units of the central power plant. Therefore let us briefly consider the relation of the turbine to the engine and their steam consumptions, obtained in recent practice in the United States. It will be noticed that I have compared power plants of the largest sizes; therefore the same plan will be adopted with respect to prime movers.

The Corliss-valve engine, used almost exclusively in America, as built by Allis Chalmers Company, has reached a maximum size to date of 8,000 horse power. Nine engines of this type and capacity have been installed in the new plant of the Interborough Rapid Transit Company of New York. At this company's (Manhattan) Elevated

* The Engineering Magazine, August, 1905, page 690.



FIGS. 55 AND 56. PRIME MOVERS IN THE PLANT OF THE INTERBOROUGH COMPANY, NEW YORK.

The upper picture shows the high-pressure cylinder side, and the lower one the condenser side of the engines in the new Subway power station.

Road plant, eight similar units have been installed. See Figures 55 and 56. The latter are plain Corliss-valve engines, while on the former only the low-pressure cylinders have Corliss valves, and the high-pressure cylinders are provided with double-seated poppet valves. As these two engines vary in their dimensions, the following table is submitted:—

	Rapid Transit Co.	Manhattan.
Diameter of high pressure cylinders, inches..	42	44
Diameter of low pressure cylinders, inches..	86	88
Stroke, inches	60	60
Speed, revolutions per min.....	75	75
Steam pressure at throttle, pounds.....	175	150

The guarantee of superheated-steam consumption for the former is 12.25, while that for the Manhattan is 13 pounds per indicated horse

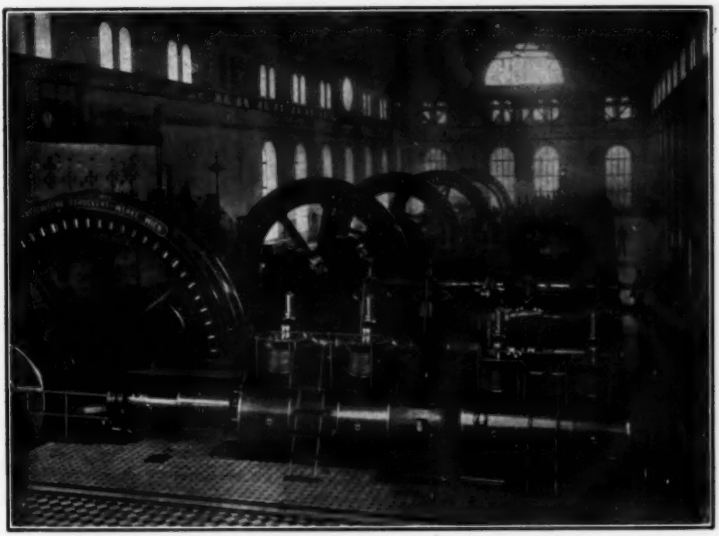


FIG. 57. INTERIOR OF THE MUNICIPAL PLANT AT VIENNA.

3,400-horse-power Sulzer engines built by the Erste Brünner Maschinenfabrik-Gesellschaft.

power per hour, operating at 7,500 horse power, for which the engines were specified. The actual steam consumption in practice of the former as well as the latter, which have been in operation for several years, is not generally known.

The 3,400-horse-power Sulzer engine as built by the "Erste Brünner Maschinenfabrik-Gesellschaft" for the twin municipal Vienna plants (as shown in Figure 57), was sold under a guarantee of 10.0

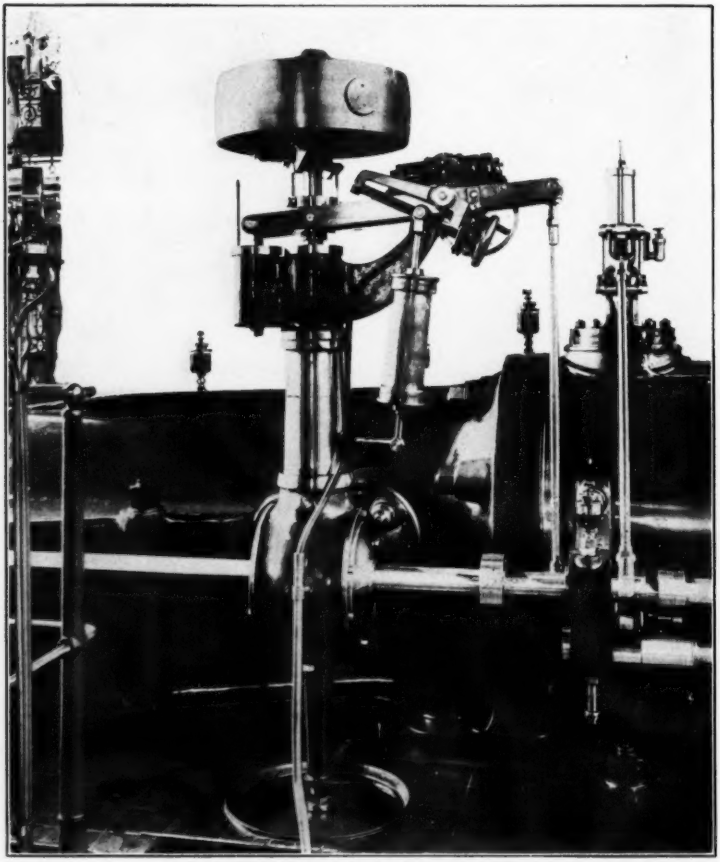


FIG. 58. ELECTRICALLY OPERATED GOVERNOR.

pounds, while the actual running test shows 9.31 pounds per indicated horse power per hour. This engine is a horizontal four-cylinder triple-expansion type with two low-pressure cylinders. The diameters are 31.5 inches, 46 inches, and two 68 inches, and the stroke 59 inches. This engine operates at 90 revolutions and 175-pounds pressure and 570 degrees F. temperature in the valve chamber of the cylinder. Each cylinder has four four-seated poppet valves operated from the main shaft by means of beveled gears, and regulated by a delicate governor limiting the variation of speed to 4 per cent. The cylinders are placed

in two rows and the cranks 180 degrees apart. The condenser pump, located below in the basement, is operated from the main crank pin.

The 3,000-horse-power Sulzer engine at the Luisen Strasse station in Berlin operates also under regular conditions with a steam consumption of 9.4 pounds per indicated horse power per hour. The advantages of superheated steam may be clearly shown in this test, which is reported in *Zeitschrift des Vereines Deutscher Ingenieure*. This engine is of the vertical triple-expansion condensing type, with four cylinders arranged in two tiers, the high and intermediate being on top. The cylinder diameters are 34 inches, 49⅜ inches, 61 inches and 61 inches, giving a ratio of 1 :2.1 :6.4, the common stroke being 51 inches, and the revolutions 83 per minute. With a pressure of 210 pounds and a temperature of 590 degrees F. in the poppet-valve, the steam consumption was 9.41 pounds, while with a more moderate temperature, 518 degrees F., the consumption was 9.49 pounds per indicated horse power per hour. With saturated steam, at 360 degrees F. in the valve chamber, the consumption was 10.1 pounds per indicated horse power per hour.

The cylinder ratio of the 5,000-horse-power Sulzer vertical engine at the Metropolitan Electrical Supply Company in London is 1 :4. The

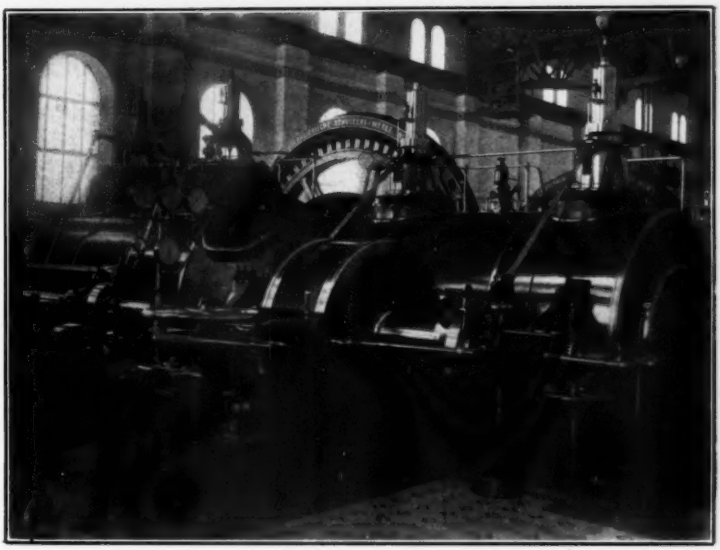


FIG. 59. REGULATING MECHANISM OF A SULZER ENGINE, AS BUILT BY THE ERSTE BRÜNNER MASCHINENFABRIK-GESELLSCHAFT.

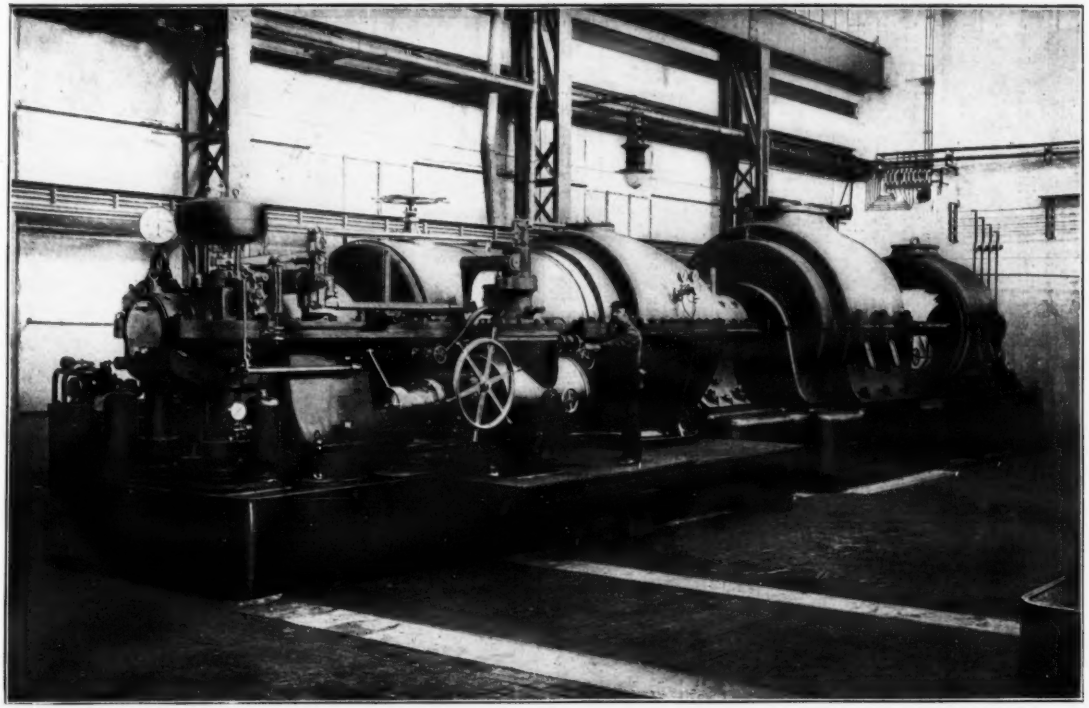


FIG. 60. BROWN-BOVERI-PARSONS 10,000-HORSE-POWER STEAM TURBINE AT THE ESSEN ELECTRIC STATION, GERMANY. Two of these turbines exhaust into one central surface condenser. We are indebted to *Power* for the use of this photograph.

two low-pressure cylinders are placed one on each side of the one high-pressure cylinder, the relative diameters being 71 inches and 50¼ inches, while the common stroke is 51 inches. The engine runs at 75 revolutions. The steam consumption, as reported in the *Zeitschrift des Vereines Deutscher Ingenieure*, for non-condensing is 22 pounds and condensing 13.7 per indicated horse power per hour. It will be noticed that although this engine is of materially greater capacity, the steam consumption, contrary to what might be expected, is increased. I have pointed out at the beginning of this paper that economy of a plant is not only due to the manufacturer, but a great part is due to the power-plant designer and to the management.

Throwing an engine-generator into parallel with units already in operation is usually done in the United States by giving the engine operator, visible or other signals from the switchboard, the switchboard operator waiting till the engine has been brought up to synchronous speed, when the switch is thrown in. The continent of Europe has adopted another practice, which has been in successful operation for many years. Upon the levers of the governor is mounted a small electric motor (see Figure 58) operated from the switchboard after the engine has reached a certain speed. Thus the switchboard operator, usually a more skilled man, has in charge the entire synchronizing of the generator. A horizontal electrically operated governor as well as the fine thorough construction of the regulating mechanism of a typical continental engine are well illustrated in Figure 59.

IX. STEAM TURBINES.*

The steam turbine, although a comparatively recent competitor in the power-plant equipment, shows steam consumption as good as, if not better, than the best reciprocating engine. The most favorable showing of all turbines running to-day is made by the Swiss or German Parsons type, although there are other makes and types pushing them closely. This may be due mainly to one of the greatest pioneers, the Brown-Boveri Company, who realizing at an early date the field of the turbine, pushed it with all possible zeal—with what success is shown in Figure 60, representing a 10,000-horse-power turbine, the largest ever built. I can however state that this company has under course of construction one of 12,000-horse-power capacity. There is no reason to believe that the limit has yet been reached, but on the

* **Franz Koester**, *Engineering Record*, Jan. 7, 1905. *Electrical World and Engineer* Feb. 18, 1905. *Western Electrician*, April 8, 1905. *Electrical World and Engineer*, June 3, 1905.

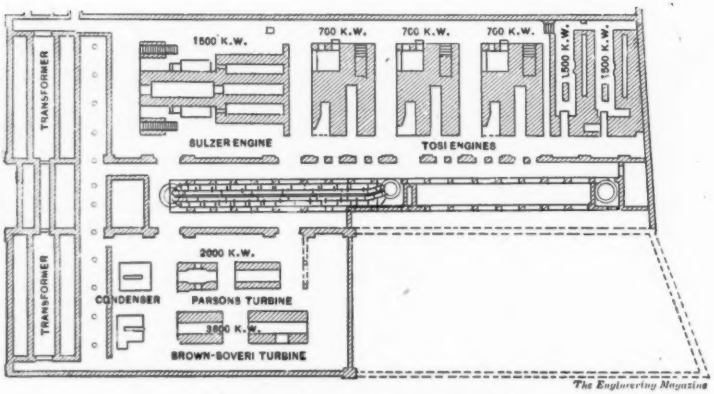


FIG. 61. PORTA VOLTA PLANT AT MILAN.

The upper portion of the plan shows the room containing reciprocating engines of 3,950 kw. output. The turbines in the lower left corner have an output of 5,600 kw.

contrary every reason to expect turbines of even greater size soon to be constructed. The advantages of large-size prime movers for central stations are much increased by the adoption of the steam turbine instead of reciprocating engines, and may be summed up as follows: As the latter has many more moving parts than the former, interruption of service is much more liable to occur on account of breakdowns. The turbine has also proven its superiority by running continuously under normal power plant conditions for some 5,000 to 6,000 hours without any sign of wear, which feat can never be duplicated even by the best built reciprocating engine.

It must be borne in mind that in having only large-size units, during the fluctuation of load, especially noticeable in city traction, some of them are forced to operate under fractional load and, therefore, uneconomical conditions, which may be avoided by the installation of units of intermediate capacity.

The space required by a turbine itself is well-known to be less than that required for a reciprocating engine of the same capacity, but the space occupied in the power plant depends entirely upon the layout where the desire and ability of the designer play a great role. Cases have already occurred where the space occupied for a turbine plant is greater than that required for an engine plant of the same size. It is without question possible to effect a great saving in floor space by the adoption of the steam turbine, an example of which is given in Figure 61, representing the power plant Porta Volta at Milan, the upper half having a capacity 3,950 kilowatts of different types of

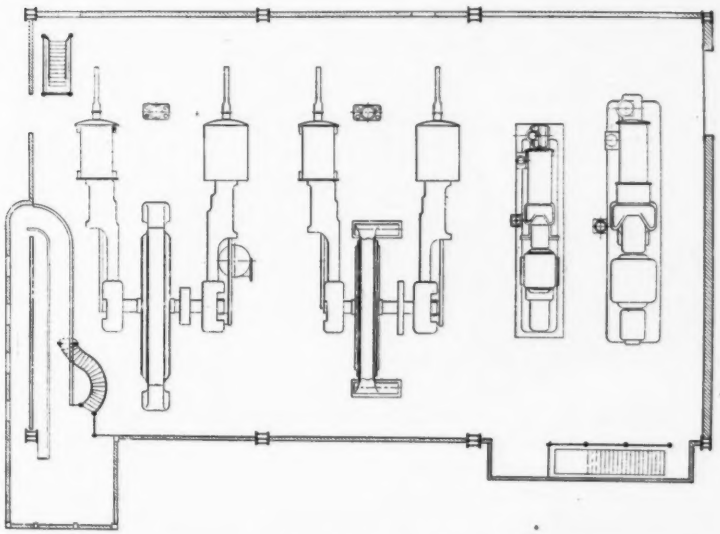


FIG. 62. PUTEAUX PLANT OF THE WEST PARIS ELECTRIC COMPANY, PARIS, FRANCE.

engines, while the lower left hand corner has installed 5,600 kilowatts of Parsons turbines. Although the latter represents an increase of 1,600 kilowatts capacity, it occupies about one-third as much space as the engine room (upper part). Another very interesting case is shown in Figure 62, representing a plan of the Puteaux plant owned by the Electro-Mécanique Company of Paris. Two turbo-generators, one of 1,100-kilowatts, the other of 1,800-kilowatts capacity, occupy the same space previously reserved for one 800-kilowatt horizontal compound engine.

The 10,000-horse-power turbo-tandem, alternating-direct current generator, as seen in Figure 60, has a total weight of 190 long tons, the turbine itself weighing 107 tons. The two generators, one 5,000-kilowatt, three-phase, 50-cycle, 5,000-volt alternating, and one 1,500-kilowatt, 600-volt direct-current, are connected to the turbine by means of isolated flexible couplings, encased in common bearings between the turbine and the generators. The entire length of the set is 65.6 feet, while the width over all is 8.5 feet, and the maximum height from the floor level also 8.5 feet. As will be noticed, all levers and hand wheels are operated from the main floor, which of course would facilitate the operation more than if done from a raised platform. Some other manufacturers of this same type of turbine

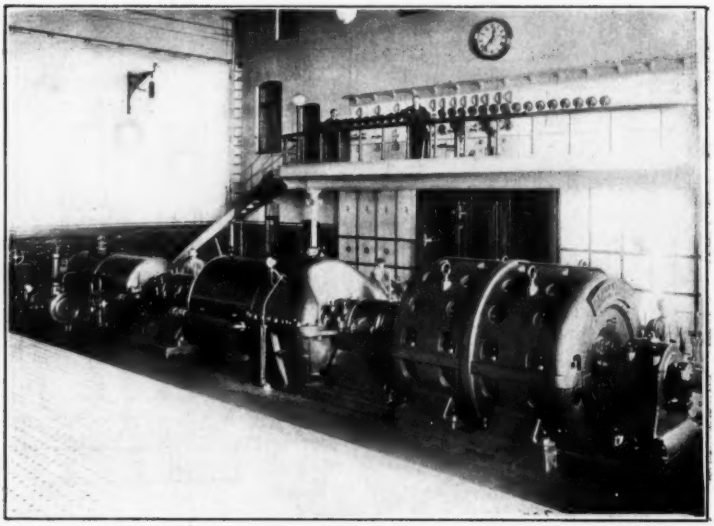


FIG. 63. LIGHTING AND STREET RAILWAY PLANT AT FRANKFORT-ON-THE-MAIN, GERMANY.
4,000-5,000 horse-power Brown-Boveri-Parsons turbo-alternator.

seem to prefer a gallery around the turbine, units even as small as 1,000-kilowatts being provided with galleries at the top of the turbine chamber. One of the principal advantages of the steam turbine over the reciprocating engine, its smallness, is apparently lost in this design. I would like to call attention to the fact that the art of design and construction of a turbine is to obtain the greatest power out of the smallest or seemingly smallest size of turbine. This of course applies also to any other type of engine, and success in accomplishing this result will not only reduce the cost but has numerous other advantages.

Although the turbine does not require a larger condenser than the reciprocating engine, it is true that the condenser outfit of the former occupies generally a larger area, usually in the basement. This is due to the adoption of the surface condenser, which gives a more economical operation, as it allows the condensed steam to be returned directly to the boiler, which in the case of an engine would be impossible on account of the presence of oil in the exhaust. Therefore the surface condenser of a turbine plant may effect a handsome saving, as already shown in the chapter on superheaters.* There

* The Engineering Magazine, September, 1905, page 833.

will be no special benefit derived from supplying the turbine (or engine) with a jet condenser unless the water is required for some other purpose. As in many cases, with the horizontal turbine, the condenser is located directly beneath the turbine in the basement, it would be good practice to install the pumps beneath the condenser, or directly at the side, in such a way that the condensed steam would flow by gravity to the hot-well pumps.

Modern common practice (Continental) in regard to the condition of steam used in turbines as well as engines is 175 to 225 pounds at a temperature from 550 degrees to 750 degrees F. The steam consumption, as has already been stated, is remarkably low there. The 4,500-horse-power Brown-Boveri-Parsons turbo-generator installed in a plant at Frankfort-on-the-Main has a steam consumption of 9.02 pounds per indicated horse power per hour, which is under ordinary operating conditions, but does not include the power required for condensing purposes, this being drawn directly from the bus bars. The above mentioned 10,000-horse-power turbine has

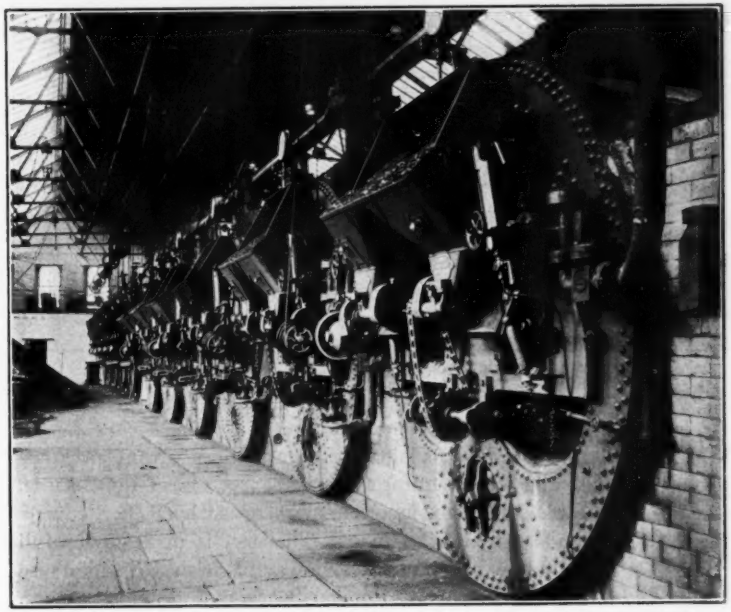


FIG. 64. PROCTOR'S PATENT MECHANICAL STOKER AND MOVING FIRE BARS.
As applied to the boilers at the Corporation Electricity Works, Huddersfield, England, by James Proctor, Ltd., of Burnley.

a guaranteed steam consumption of about 9 pounds per indicated horse power per hour, to which must be added 1½ per cent for motor driven auxiliaries. Two of these turbines exhaust into one central surface condenser. The guarantee for the 5,000-kilowatt turbines in the St. Denis plant of Paris is 9.4 pounds per indicated horse power per hour, in which case the turbines will have to operate under the following conditions. The turbines will run at a speed of 750 revolutions with a pressure of 175 pounds and a temperature of 630 degrees F., while the vacuum must not be less than 27 inches. The 1,500-kilowatt turbine, with the exciter coupled directly onto the main shaft at the

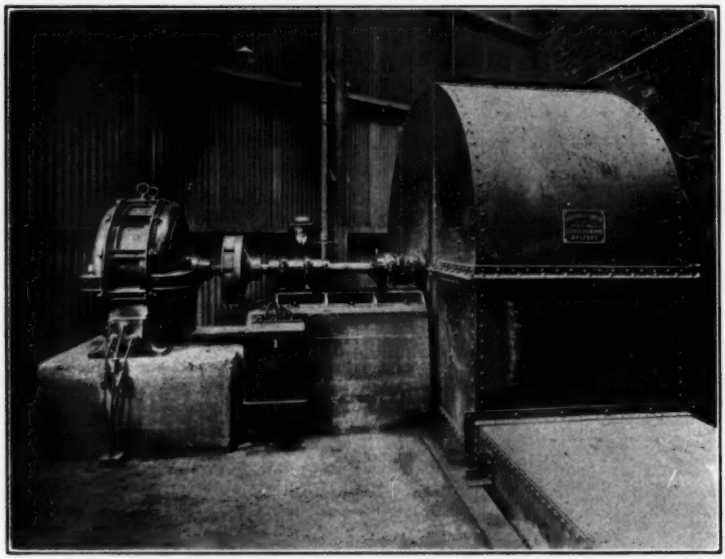


FIG. 65. SIROCCO CENTRIFUGAL CASED FAN, DIRECT COUPLED TO 100-HORSE-POWER ELECTRIC MOTOR.

Three sets supplied to the Carville Power Station of the Newcastle-on-Tyne Corporation by Davidson & Co., Ltd., Sirocco Engineering Works, Belfast.

Sheffield electricity works, England, runs with a steam pressure of 190 pounds, and a temperature of 475 degrees F. at the throttle. the most favorable steam consumption, as recorded by S. E. Fedden* being 18.4 pounds per kilowatt hour. This test is made under full load. The guarantee of the 5,500-kilowatt British Westinghouse turbines in the Chelsea plant, London, was 15.6 pounds, with a vacuum of 26 inches, while with a vacuum of 27 inches it was 13.2

* *Engineering*, March 10, 1905.

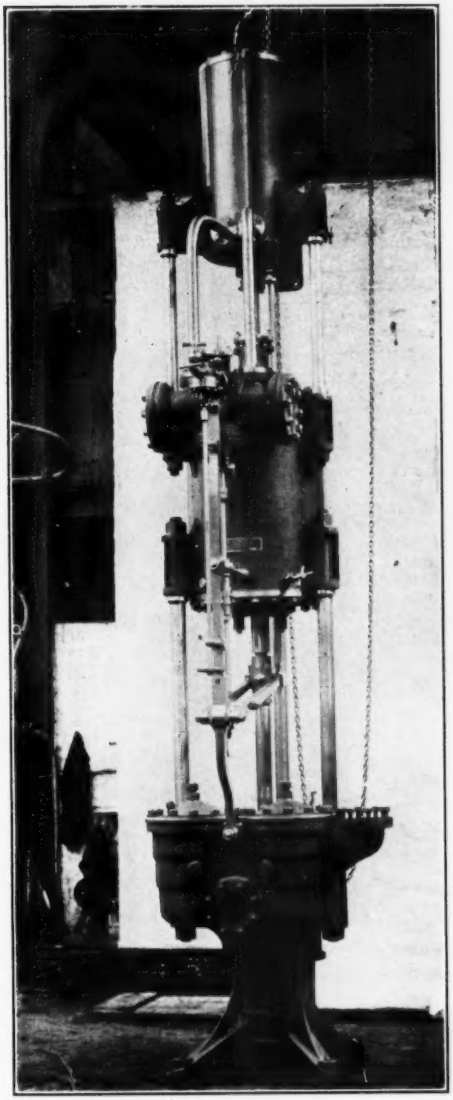


FIG. 66. TANDEM COMPOUND FEED PUMP.
G. & J. Weir, Cathcart, Glasgow.

pounds per indicated horse power per hour. These turbines make 1,000 revolutions with a steam pressure at the throttle of 165 pounds, superheated up to 465 degress F. I can state that steam consumptions considerably lower than 9 pounds per indicated horse power per hour have been obtained, these under purely test conditions, however, which do not count for power-plant operation.

In addition to the advantages already mentioned in connection with the steam turbine must be added the increased ease of governing which is due to the rotary motion, which makes it therefore especially well adapted for operating in multiple with other units. A by-pass valve allows steam to enter directly into the intermediate or lower-pressure chamber, thereby taking care of a sudden overload more quickly than would be possible by starting up a new engine: this is also of service in case

of failure of the condenser. By doing this, of course, the steam consumption is increased. To all of the advantages already suggested must be added the cheapness of the turbo-generator unit as compared to the engine-generator set; a 6,000-kilowatt unit of the latter type may cost about twice as much as that of the former.

It may be of interest to give the following data in connection with turbines and modern reciprocating engines. The total weight of a 5-stage 5,000-kilowatt Curtis turbo-generator is about 250 long tons, and it is about 30 feet high (above floor level). The 6,000-kilowatt Brown-Boveri-Parsons, turbine alone weighs about 80 long tons and costs about 45 francs per kilowatt, while the generator of this set weighs 55 tons and costs about 25 francs per kilowatt. The rotating parts only of an 8,000-horse-power Allis-Chalmers engine

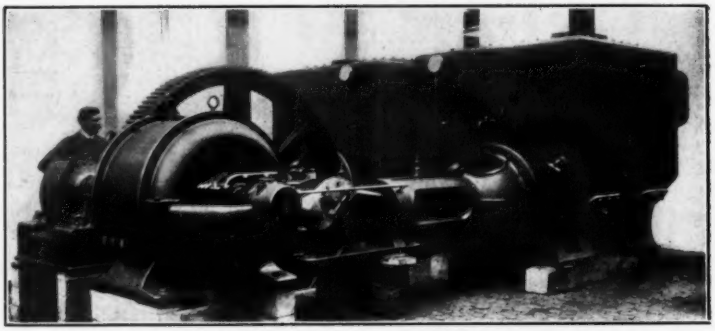
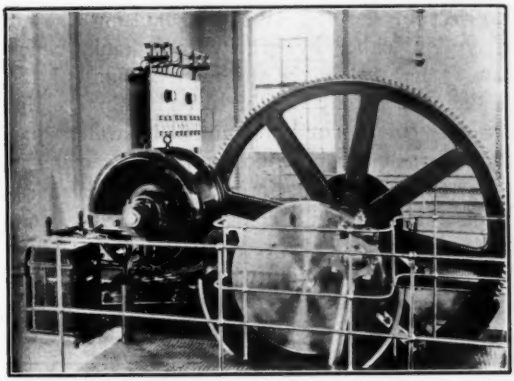


FIG. 67. MOTOR-DRIVEN CONDENSER FOR A 5,000-HORSE-POWER BROWN-BOVERI-PARSONS TURBINE.

together with a revolving field of a 5,500-kilowatt Westinghouse alternator weighs 206 long tons. The 3,400-horse-power Sulzer condensing engine at the Vienna plants weighs (without generator) 245 long tons and costs 250,000 kronen.

X. CONDENSERS AND AUXILIARIES.

A condenser is adopted to create a vacuum as high as possible, which in turn assures a greater efficiency of the engine or turbine, this being generally done by bringing the exhaust steam into close contact with cooling water. The water necessary for this purpose for each particular case depends entirely upon the temperature of the exhaust steam; commonly 30 pounds of water are required per pound of exhaust steam to be condensed. As not all waters can be used with all types of condensers, the latter must be chosen with special regard to the particular grade of cooling water supplied. The con-



densation may be accomplished either by injecting the water directly into the exhaust steam or by conducting the steam over surfaces cooled by circulating water; hence the names jet and surface condensers. These condensers have been designed and constructed in many different forms, most of which are not commonly found in power stations and are therefore without the scope of this article. The jet condensers are classified as the "wet" and "dry" condensers, the words wet and dry, however, by no means being used in their true sense and simply to classify the following types. In the case of the former, the air pump extracts the condensed steam and injected water together with the air, these condensers being often operated directly from the main unit by means of a rod; as at Vienna, where the condenser is connected to a Sulzer engine. In the case of a dry jet condenser, the air pump extracts the air and uncondensed steam only, while the condensed steam and injected water are conveyed off automatically. This type of condenser is also known as the "barometric" or "fall pipe" condenser; see Figure 56, where an Alberger condenser is connected to an Allis-Chalmers engine. A fair degree of vacuum may also be obtained by connect-

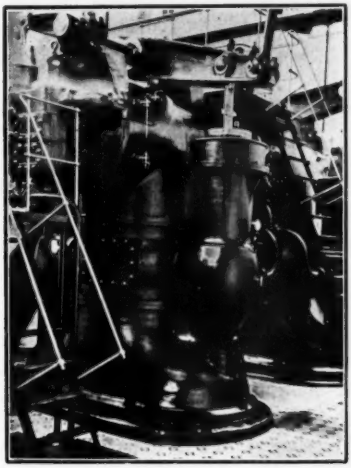


FIG. 68. MOTOR-DRIVEN PLUNGER PUMP FOR COOLING WATER AT THE TWIN POWER PLANT IN VIENNA.

The upper figure on this page shows the driving machinery; the lower shows the pump, which is placed on the floor below that carrying the motor.

ing the air suction direct to the tail pipe and omitting the air pump. The water may flow either by gravity to a tank, which must be not less than 25 feet below the injection opening of the condenser, as the vacuum will readily lift the water to that height, or where such an arrangement cannot be obtained the water must be injected by means of a pump, in which case the vacuum in the condenser will assist the pump to perform its duty. The barometric condenser may also be successfully employed as a central condenser where more than one engine exhaust to one condenser, as in the new Kingsbridge (New York) station where the exhaust pipes from four 4,500-horse-power engines are connected to a single 54-inch main leading to a single condenser capable of handling the ex-

FIG. 69. COOLING TOWERS AT THE "BILLE" PLANT, HAMBURG.

haust of 25,000 horse power, and as there are four such condensers for sixteen engines it will be seen that in case of an emergency the plant may be operated on three condensers. The surface condensers may be classified as "closed" or "open" type. The former generally consists of a number of tubes in a closed chamber through which the water passes, a counter current being usually adopted. In the open type, the exhaust steam may pass through a series of tubes surrounded by cooling water in trays directly exposed to the atmosphere. This apparatus is not as favorably considered as the closed type, which is the best type in existence for use with steam turbines on account of the oil-free exhaust.

In order to assure a good vacuum all leaks must be avoided, which result may be facilitated by placing the condenser as close to the engines as possible and by using, as already stated, water sill

flanges, which is easily possible in vertical runs. Provision must also be made for free atmospheric exhaust in case of failure of the condenser.

The power required for running the auxiliaries should be not more than 5 per cent. of the total power; good engineering practice however allows only 2 per cent. This consumption has proven possible in many plants on the continent of Europe. These auxiliaries are usually electrically driven, and may be either of the plunger or centrifugal type. As Continental practice has long ago proven the efficiency of this system, and as the British practice is rapidly tending in this direction, I do not doubt but that it will ultimately be universally adopted.

Where the supply of cooling water is limited, cooling towers may be advantageously installed in order to use the water over again. There are two types of coolers—1, when the tower is of sufficient height to create a natural draft assisted by the heated air from the condensers; 2, when the air is circulated by one or more fans, thus considerably reducing the height of the tower and also occupying less space. Both of these types of cooling towers may be built of either wood or steel construction, the latter being usually of cylindrical type. The accompanying illustration, Figure 69, gives a splendid view of a natural-draught cooling tower installed in the power plant Bille, Hamburg. A single combined hot-and-cold-water pump may force the water through the condenser, whence it runs to the hot well, is taken up by the pump, sent to the cooling tower, and again taken up from the cold-water pit to the condenser. Where the distribution troughs of the cooling tower lie below the level of the condenser outlet, it is possible to depend upon gravity to take the hot water to the tower, thus reducing the power required for auxiliaries. The oil carried in the exhaust from reciprocating engines is usually abstracted by means of overflows, but in case any of this water is to be again fed to the boiler great care must be taken to filter out all the oil carefully, as the disastrous effect of the presence of any oil in the boiler is well-known.

HIGH-SPEED STEEL IN THE FACTORY.

By O. M. Becker and Walter Brown.

In the present article, which is the second of a series containing a very valuable practical study of the use and effects of high-speed tool steel in one of the largest American machine shops, the details of introducing the new steels, both with regard to the men and to the machines, are discussed. The first article, which appeared last month, showed that, in general, the factory manager will find it to his advantage to adapt his existing equipment to the new conditions as far as possible, and work it to the limit until it is worn out, rather than to instal new machines at once. The carbon tools should be replaced by the alloy steels only gradually, each case being considered on its own merits, and in introducing the new tools, it will be found economical to secure the services of an expert.—THE EDITORS.

II. CONTROLLING PRINCIPLES IN MAKING THE INTRODUCTION.

ANY business organization, and particularly that of a big factory, is a delicately balanced mechanism which cannot be rudely disturbed without seriously interfering with its smooth operation. There are doubtless some changes of a sweeping nature that could be made with great advantage in almost every large industrial plant, even at the risk of some confusion and temporary disorganization. It is usually safer, however, to make important changes gradually. The matter of changing the materials used in the manufacturing tools might seem to have little or no bearing upon the factory organization and management outside the one feature of costs. The question is not, however, one of tools and costs only. There is another factor that requires even more careful consideration than either of these, namely, the men who use the tools and through whom the costs will be changed. Tools could be promptly designed for the desired new conditions, machines altered, and costs re-figured with little trouble; but unless the workmen are also considered there is almost certain to be rough water ahead. For this reason mainly it is desirable to make the change cautiously and not too abruptly, always with due and just consideration of the man who uses the tool. There is a second reason for making such a change without unnecessary haste; namely, the need for trying out the various jobs to ascertain just where high speed tools can be used to advantage. For, as pointed out in the previous paper, there are likely to be many cases where it is just as well, and possibly better, to use carbon or self-hardening tools. Really, however, the latter need not be seriously considered, mainly because the socalled self-hardening is only an intermediate step between carbon

and high-speed steel, and its promoters are, for the most part, turning their attention to the high-speed product. In order, therefore, to secure satisfactory results it is necessary to make a careful study of the situation as it exists in the particular factory in consideration.

That is a very conservatively or ignorantly managed machine shop wherein no high-speed steel at all is used. On the other hand, the number of shops making use of the new steels to anything like the extent it could profitably and satisfactorily be done, is not large. A small amount of the steel is used in many shops. In most such cases there is little inclination to make a large use of it because the results have been much short of those expected. The failure to obtain satisfactory results under these circumstances is usually due to the very fact that so little is used, in consequence of which there has been no expert development of the subject, the matter being usually left in the hands of men understanding neither the nature nor methods of treatment of the alloy steels. It would be surprising indeed if, under such circumstances, wholly satisfactory results should be obtained. The very first thing that ought to be considered in planning for the extensive use of high-speed tools is intelligent direction and handling. This given, there can be no question as to obtaining results.

Just here it is well to consider a few cautions whose observance will be certain to prevent many failures or half-successes and disappointments.

It is unnecessary to experiment with all, or many, of the fifty or more brands of alloy steel now upon the market to determine which is best, or to try out every job in the factory to find out where it is profitable. While it is true that some of the brands are for general purposes better than others, and that certain ones are probably better adapted to some jobs than to others, on the whole it is not desirable to undertake to test more than one or two at the beginning. It is important only that the brand selected for first introduction be one well-known for its merit. The introduction once made and workmen educated to the proper management and use of the new tools, there will be time enough to carry on careful comparative tests upon the various makes. If reliance be placed upon the regular tool makers, even if under the direction of an expert thoroughly familiar with alloy steels, there will undoubtedly be troubles enough in acquiring the necessary experience and skill to make and handle them properly, without the additional distractions incident to comparative tests. And while also it is true that every job and tool should be related according to the conditions governing in each case, there are nevertheless typical

jobs that can be utilized for drawing general conclusions and for determining the adaptability of a new tool to that class of work and machines. When it comes to fixing new rates, of course, certain data must be secured for each job—a matter taken up hereafter.

Second, the use of existing installations without considerable modification will not yield any astonishing results. Unless the machines already in use are adapted to the greatest possible extent to the new conditions, the economies effected will be, on the whole, rather moderate—sufficient in most cases, however, to demonstrate the advantage of using the new tool. This feature will be more fully discussed in a later paper.

Third, it is important to obtain the co-operation and interest of the men who are to use the new tools. Usually they look with suspicion and disfavor upon anything that tends to require greater exertion in earning a day's wages or threatens to diminish the number of men necessary to secure the required output. The use of high-speed tools, from the very nature of the case, presumes more activity on the part of the operator in a given time. He must handle more pieces and do more work, and that at a higher nervous pressure. He is justly entitled, in return for his increased exertion, to a share in the profits. Any attempt of the employer to monopolize the profit will be properly resented by the workmen, with the result that a relatively unsatisfactory showing is made.

The question now presents itself, how to take up the high-speed-tool proposition—what method or system to employ in determining when and where to use it, as well as the collateral questions, not the least important of which is that of the readjusted piece-work price. It would be futile to say dogmatically that one or another method ought or ought not to be employed. Any method will serve if it be not too cumbersome and if it be used intelligently by men having some familiarity with the matter in hand. Obviously it will be desirable to make use of some method harmonizing with the system of management in force in the shop or factory. This holds true of a small shop employing few men and machines as well as of a great factory.

Of the two systems of factory management ordinarily found in practice, the monarchical one-man system and the oligarchical committee system, the latter if applied to the high-speed-steel proposition would have the advantage of creating a greater immediate interest and would necessitate less diplomacy and tact in the dealings with the workmen and foremen affected. It is, however, open to the objection that it is somewhat cumbersome and puts a good many fingers into

the pie. If one or more members of the committee have a good working knowledge of alloy-steel properties and behavior, so much the better. If not, it will be almost necessary, in order to make headway and to avoid disappointments, to secure the services of an expert who can give direction and point to work of the committee.

If the whole matter be put into the hands of one man with more or less experience in handling high-speed steel, it is important that he be endowed with tact enough not to procure the distrust of the workmen and the antagonism of the foremen. Lacking in this respect, the difficulties will be greatly increased. For this reason it is desirable to select a man already familiar with the factory system and men, if such a one be available.

Evidently, the point of attack in making an introduction of high-speed tools into the factory or shop will be by way of those jobs that are especially trying to the tools in use, and because of the simplicity of the tools, preferably through turning operations. Where tool holders are in use the expense for tools for this class of jobs is insignificant. There are however certain objections to the use of tool holders, considered more fully hereafter, which arise from the impossibility of attaining the greatest practicable speed or heaviness of feed, so that it is much better to use solid tools. But these also are simple in form, except for jobs having special requirements, and offer fewer difficulties to the tool maker than most other tools.

Suppose for example, the job selected is that of finishing a high-carbon shaft requiring a long cut. Without any change in the speed or feed there will be an immediate advantage apparent in that the new tool will finish many more pieces at a grinding than was previously possible. Usually it will be possible also to speed up the lathe so as to gain largely in cutting time. Unless there should be some unusual conditions there ought to be no difficulty in reaching a speed from 100 to 300 or 400 per cent. faster than with carbon-steel tools, and from 25 to 100 per cent. faster than with the self-hardening.

The determination of the maximum speed will doubtless require close study of the quality of the product, the limitations of the machine, and the life of the tool; and it may therefore require some little time. It is worth while establishing the limit with some degree of definiteness, however, so as to get a criterion for all similar jobs. An approximate standard of speed once determined for each class of jobs, much time will be saved and trouble avoided by using it in all cases to which it is applicable until experience shows modifications to be of advantage.

In fixing upon such a standard certain elements will at once become evident as determinants. First of all will be the nature of the material, whether of high- or low-carbon steel, malleable, or of soft or hard gray iron. Obviously the same speed would be out of the question with all these, even if all other conditions could be made similar. A second factor is the age and design of the machine used, which is assumed to be of the ordinary type of present installation. Unless it is pretty rigid and a little worn it is quite likely to spring under the higher requirement, so that accuracy of work cannot be depended upon if speeded too high. Furthermore the piece itself may give also, and add to the difficulty.

Again, there is the question of additional driving power to take care of the increased speed. In this connection it should be remembered that while the amount of power required to drive a machine at the higher speed is greater than at the lower, the total quantity necessary for doing a piece of work is no greater. Indeed, in most cases the amount is actually less, because of the greater efficiency at the high speed.

Still again, if the piece turns on centers there arises the difficulty of keeping the centers true. A small piece rotating very rapidly may easily burn off the center in a short time. But this is not a serious matter. The lathe center itself can be made of high-speed steel and the whole difficulty obviated.

It is seen that every job, or at any rate every class of jobs, must be studied with reference to a great variety of relations and regarded with respect to its own peculiar limitations. The great variety of conditions makes it very difficult to generalize or to mark distinct classifications of jobs. The usefulness of such a classification in respect to speeds has already been pointed out. It is equally useful in a study of the making and tempering of the tools, as will be shown in a later paper. The following is given as suggestive:

1. Hard steel, large diameter, heavy cut.
2. Hard steel, large diameter, light cut.
3. Hard steel, small diameter, light cut.
4. Soft steel, large diameter, heavy cut.
5. Soft steel, large diameter, light cut.
6. Soft steel, small diameter, light cut.
7. Malleable, small diameter.
8. Malleable, large diameter.
9. Gray iron, large diameter, heavy cut.
10. Gray iron, large diameter, light cut.
11. Gray iron, small diameter, light cut.
12. Gray iron, extra hard.

This classification by no means covers the ground completely, and

lacks a good deal of fitting all jobs. The most that can be said of it is that it is reasonably concise and offers a convenient basis of tentative reference for most jobs. In a later paper dealing with practicable feeds and speeds, an attempt will be made to designate approximate standards in connection with this classification, which may serve as a series of convenient starting points in testing and trying out new tools.

In this discussion lathe tools alone have been considered thus far, for reasons already given. Nearly all that has been said will apply with equal force to other kinds as well; and if tools such as drills, reamers, millers, and similar cutters, are bought ready made to specifications, or are made and hardened in the shop by tool makers thoroughly acquainted with the new steels, there is no reason why such should not be used from the beginning.

Of the making of tests there is no end, in a well administered industrial plant. The management that is satisfied with what is, inevitably finds itself distanced by its more energetic and wide awake competitors who stand ready to inquire into everything that has even slight promise of economies to come. The high-speed steels certainly have very much of promise in them, and have indeed thoroughly proved themselves wherever given half a chance. Clearly it is worth while to do a good deal of testing with this new tool material. But there are tests, and tests. The endurance and cutting capacity of a drill, for example, can of course be determined by drilling a plate full enough of holes to convert it into a sieve; and that of a lathe tool by paring down rods and cylinders indefinitely. Doubtless such tests were once valuable. They are however no longer necessary and but rarely desirable. The extraordinary performances of these steels are too well known. If it is desired to learn the life of a tool in comparison with another, it can be done just as well, and much more profitably on a regular job and under the conditions that usually govern in the manufacture of a commercial product.

The try-out or test, whether made by the high-speed-tool expert, the committeeman, the foreman, or the workman, of course has for its end the determination of some fact or number of facts upon which generalizations may be based or which will assist in arriving at the cost of production under the changed conditions. It is therefore essential that the data gathered be accurate and relevant to the end sought, and preserved in form for convenient reference. Without such a record the readjustment of the workman's pay, upon which the whole question of high-speed tools chiefly hinges, is merely guesswork with no rational basis, just as rate fixing under the usual

circumstances is in nearly all shops. That is to say, the use of the new tools is, the quality of the work being satisfactory, a question of increased profit or perhaps it were better to say, of reduced cost of production. Since the cost of production is chiefly that involved in the piece-work rate paid to the workman, he not only is the center of attention on the part of the investigator, but very naturally becomes much interested himself.

Now the piece worker is extremely sensitive to changes in his rate, and one of the great problems in factory management is to keep rates so adjusted as to get the most economical production consistent with the required quality of the output. The cost of production however is not altogether determined by the piece-work price. Among the other factors one of the most important is the intelligence of the body of workmen and their attitude toward the employer. In proportion as the operatives are ignorant, unskilled, discontented, and lacking in interest, the cost of production goes up. Without a reasonably satisfied and loyal corps of employees there can be no such thing as continued profitable production, no matter how cheaply work may be turned out for the time being. In the long run, strikes, shutdowns, idle machinery and capital making no turnover, a constantly changing body of workmen—all must be reckoned as a part of the cost of production; and all point to the importance of the human factor in the equipment and running of the factory—a factor all too frequently ignored or treated with scant regard to sound principles of mechanics, which in this case are also sound principles of humanity and justice. That is to say, one of the chief elements in the problem of introducing high-speed tools is to adjust the new rates with immediate profit to the management and justice to the operative.

A fundamental principle in any such readjustment therefore is that the workman is to have an increase in total earnings commensurable with the increased work required of him under the new conditions. Not a temporary increase, to be wiped out at an opportune moment, as most managers know so well how to do; but a permanent increment assured in good faith by merited confidence in the employer. Disregard of this principle is sure to limit the ultimate profit in ways often indirect and intangible but none the less positive and appreciable. The amount of increase obviously will depend upon a number of things, but especially upon the amount of saving effected and the increased exertion; and it ought in every case to be satisfactory to the man, as it usually will be if he is tactfully taken into counsel.

Now as to fixing the rate:—Of course the foreman, or whoever

is charged with rate fixing, could probably make a passable guess at a fair price after making a try-out or watching one. There are however so many chances for mistake that the only safe way is to determine a new rate directly from the data gathered and recorded in connection with each particular job. Suppose a concrete example be taken, an actual case.

The following data are available in the pay roll and other regular factory records; season's requirement, 24,000 pieces; average daily output (two lathes), 92 pieces; piece-work rate, $2.125 per hundred; average daily wage, $1.91.

Observation of the job develops, among others, the following with reference to the performance of the self-hardening tool: actual cutting time, 8 minutes; cost of tool per hundred pieces, 3 cents; pieces finished per grinding of tool, 5; average time required per grinding and setting of tool, 5 minutes. A little calculation, as here shown, brings out that the time required for finishing a piece is 13 minutes, and the time allowance for setting up, handling, cleaning machine, and other lost time, 4 minutes:

> Average daily output (10 hours or 600 minutes), 92 pieces;
> whence the average time per piece = 600 ÷ 92, or 6.5 minutes.
> But since two machines are operated, the actual time required per piece = 2 x 6.5, or 13 minutes.
> Since the time required for grinding and setting the tool for 5 pieces is 5 minutes, the time per piece = 1 minute.
> The actual cutting time (stop-watch observation) = 8 minutes.
> Then the time allowance = 13 — (8 + 1 =) 9, or 4 minutes.

Taking now the data developed by observation upon the performance of the high-speed tool, we have the following result:

Actual cutting time (stop-watch observation), ...	4.5 minutes.
*Time for grinding and setting tool, per piece, ...	.2 minutes.
Time allowance (handling, etc.), ...	4.0 minutes.
Total time for finishing, per piece, ...	8.7 minutes.

But as two lathes are operated, the finishing time per piece is only half as great, or 4.35 minutes.
Whence the daily output is (600 ÷ 4.35 =) 135 pieces, or more than 50 per cent. greater than before.

It will doubtless be asked by some, why go to all this trouble to find out how many pieces are produced a day? Why not let the foreman work the job for a short time? or why not count the pieces at the end of the day and be done with it? The answer is that these methods

* It is worthy of note that 22 per cent. of the time saved is the result of fewer grindings and settings of the tool. Of course the proportion would be much less in any job where the material to be machined was of the usual softness.

TOOL TEST NO. .....

TOOL ..... NO. ..... LOT. .....

OPERATION ..... PIECE .....

MATERIAL ..... CONDITION .....

MACHINES OR SPINDLES OPERATED ..... LUBRICANT .....

Record of Grinds

No.	Min. per Grind	Pieces Finish'd	No.	Min. per Grind	Pieces Finish'd	No.	Min. per Grind	Pieces Finish'd
1			16			31		
2			17			32		
3			18			33		
4			19			34		
5			20			35		
6			21			36		
7			22			37		
8			23			38		
9			24			39		
10			25			40		
11			26			41		
12			27			42		
13			28			43		
14			29			44		
15			30			45		
Total			Total			Total		

Production Record

Day	Finish'd	Scrap'd	Day	Finish'd	Scrap'd	Day	Finish'd	Scrap'd
						Total		

Workman ..... Foreman .....

Date, ... Department .....

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FIG. 1. CARD RECORD FILLED IN MOSTLY BY WORKMAN ON THE JOB.
It is convenient to indicate the different tool steels by differently colored cards. Comments made on back of card.
Original 6 by 4 inches.

TOOL TEST NO. .....

PIECE ..... OPERATION .....

MATERIAL ..... CONDITION .....

TOOL ..... SIZE .....

ANNUAL REQUIREMENT ..... PIECES

Tool Number	No. ____	No. ____	Gain
Speed, (Feet per minute)			
Feed, (Inches per Revolution)			
Cut, (Depth)			
{ Machines / Spindles } Operated			
Cutting Time, (per Piece)			
Grinding Time, " "			
Time Allowance " "			
Actual Time for Operation,			
Daily Output			
Rate per Hundred Pieces			
Cost of Tool " "			
Cost of Power " "			
Interest & Depreciation Hundred Pieces			
Overhead Expense " "			
Cost of Scrap " "			
Total " "			

Saving on Year's Requirement .....

..... { Machines / Spindles } Available for ..... Days

Daily Wages of Workman — Former, ... ; New, ...

Duration of Test, ... to .....

New Rate in Effect, ...

Date, ... Department .....

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FIG. 2. RECORD OF DATA AND RESULTS.
Cost of Power, Depreciation and Interest, and Overhead Expense are rarely of sufficient importance to require consideration. Remarks made on back of each card.
Original 6 by 4 inches.

do not take into account all the factors, such for instance as the workman "soldiering" at his job; and make no allowances for variants that may on the whole be of considerable consequence but of irregular occurrence, as for example accidents to the machinery or a shortage in the supply of material. As previously pointed out, all such variants ought to receive due weight in making changes, so that there will be no necessity for "doctoring" afterward. A try-out by the foreman or expert is useful as a check against the calculated output; and so is a count of, not one day's, but say a week's production. Alone they are insufficient.

If no change in the rate were made, in the job under consideration, the earnings of the workman would be $2.87 per day under the new conditions, as against $1.92 under the old. Accepting the principle that the operator should have a substantial (and permanent) increase in pay for his increased exertion, and that he should be consulted in the matter so as to insure an arrangement satisfactory to himself and the management, a conference with the workmen discloses that he will be very well satisfied with an increase of 35 cents a day, which would bring his daily wage up to about $2.25. This would make $1.66 2/3 per hundred. Leaning toward the liberal side, suppose that the rate be fixed at $1.75, allowing the workman a wage of $2.36; the management will still have made a reduction of about 17½ per cent on the item of labor alone. This item however is not the only one through which a saving is made, as will be seen directly. In fact it includes only about a third of the total saving in this particular case. Let us see what some of the other items are.

First may be considered the cost of the tool. Usually little, if any, economy may be expected in this item, except when it is found expedient to use inserted cutters. In this instance however, because of the hardness of the material worked upon, it happens that the cost of the tool is reduced from 3 to 0.8 cents per hundred pieces machined; or a total economy of $5.28 on the year's output.

The question of power is in this instance ignored because of the difficulty of measuring the amount used. If a motor drive is in use, the measuring of the current consumed under both conditions becomes an easy matter. On the whole this item is usually negligible.

The matter of insurance and of interest on capital invested, as well as that of depreciation and repairs, is commonly overlooked in dealing with the high-speed-tool proposition. At times however it assumes an importance that would not ordinarily be suspected. Where the already installed equipment is used with the high-speed tools the

higher duty required of the machine wears it out so much more rapidly than before that the item of depreciation usually balances itself, if indeed it be not over-balanced in favor of the old tool. But when the new tool is used in a new machine designed for the heavy duty, the item often assumes proportions sufficiently large to justify attention.

The most important saving in the job under consideration happens to be, not in labor, as is usually the case, but in material scrapped. Ordinarily this is a matter entirely overlooked; and indeed in most cases it is not sufficiently important to justify serious consideration. In this case, however, the rapidly dulling tool formerly did such imperfect work that something like 5 per cent. of the pieces were scrapped; and since each was worth (material only) about $ .25, the loss was considerable. The high-speed tool made it possible largely to eliminate this source of loss, with the result that there was a saving of $ .665 per hundred pieces machined.

Summarizing the various items entering into the total saving, we have the following:

	Self-Hard.	High-Speed.	Economy.
Piece-work rate, per 100 pcs., ...	$2.125	$1.750	$.375
Cost of Tool, " " "	.030	.008	.022
Power, " " "		Neglected.	
*Insurance and Interest, per 100 pcs.,	.072	.049	.023
†Depreciation and Repairs, " " "		Neglected.	
Scrap, net loss, " " "	1.050	.385	.665
Totals.....	$3.277	$2.192	$1.085

On the basis of the year's production, 24,000 pieces, this is a saving of $260.40. Of this amount $90.00 is for labor alone.

The case we have been considering is not a typical one. Indeed it was selected mainly for the reason that it shows clearly what high-speed steel means in cases where ordinary tools are quite out of the question and self-hardening ones unsatisfactory. The use of high-speed tools was here indicated quite aside from the saving to be effected, and it must not be thought that under ordinary circumstances an equally good showing could be made.

* Based upon 4 per cent. of cost of machines, for time they were actually in use upon this job.

† Though no economy is effected, and on the contrary a loss may be sustained because of the shorter life of the machine, there is an actual advantage in that capitalization is virtually reduced because the two machines become available for other work during 83 of the 261 days they were formerly required.

EDITORIAL COMMENT

MORE than five years ago, before either the British or the American Pacific cable was constructed, this Magazine advocated emphatically the consideration of the northern great-circle route, as by all considerations the best path for a Transpacific cable. In our issue for November, 1899, in a leading article of force and clearness, Mr. Harrington Emerson showed the great advantages of this route, extending by short coast cables from Seattle to Cape Flattery, and thence via Dutch Harbor to Yokohama and Manila, branching to the mainland via Vladivostok. The cost of the construction was shown to be far less than that of the route of long distances and greater depths, while the commercial advantages, both as to trade connections and cheapness of operation, were fully demonstrated. The plan did not appeal to government officials, however, as they had already committed themselves to the fetish of an 'all-American" cable, regardless of the fact that those cables which are protected by the joint interests of several great powers are far safer in time of war than those belonging to a single nation.

Now, however, the demand for cable communication with Alaska has resulted in the completion of a large portion of the northern route, precisely as advocated in these pages, and it is rather amusing to find that those officials who turned the plan down in such a summary manner are the ones who step forth into the lime-light and graciously accept all the credit for the plan. All that we ask is that they proceed with the good work and hasten the connection of the Alaskan lines with the Japanese system, confident that the commercial advantages which we advocated five years ago will continue to act with increasing effect over the line of least resistance.

* * *

IT is with feelings of deep regret that we record in these columns the death of Professor Franz Reuleaux, which occurred at Berlin on August 20. Professor Reuleaux was so well-known to American engineers, both by his monumental writings and by his charming personality, that in his death many members of the profession mourn the loss of a personal friend. From his early associations as one of the distinguished group at Zürich, in which were numbered Zeuner, Clausius, and their colleagues, to the severance of his work at the expiration of his forty years of service at the Royal Technical High School at Charlottenburg, Professor Reuleaux stood as the exponent of all that was highest and best in the science and practice of engineering.

As a pupil under Redtenbacher, he found the science of machine design just emerging from the bonds of empiricism, and as a professor and author he joined in giving it its true position as a branch of applied science, based upon rational considerations and broadened into wide fields of usefulness. It is only necessary here to mention the names of a few of his works, as the "Constructor," the "Theoretical Kinematics," the "Applied Kinematics," and a long list of addresses and papers in the technical press and before professional organizations, to recall the services which Reuleaux rendered to the engineering profession. His name

will long remain in the Hall of Fame of the engineer as an example of great natural powers directed to high aims, and many who are left behind will mourn him as a master, instructor, and friend.

* * *

WHILE there is at present a lull in work upon the Panama Canal at the Isthmus, with the exception of the continual prosecution of the sanitary campaign, the engineering side of the subject has been transferred to Oyster Bay and to Washington, in connection with the work of the Advisory Board, to which body the fundamental features of the work have been referred for opinion. This Board includes among its numbers probably the most distinguished living members of the engineering profession in connection with waterways and hydraulic problems, and hence every portion of the subject will doubtless be given the benefit of the highest expert opinion available.

Among the American members of the Board are included Major-General Davis and Captain John C. Oakes, both of the United States Army; Brigadier-General Henry L. Abbot, U. S. A. (retired), whose papers upon the hydraulic problems of the canal in this Magazine have attracted much attention, and whose recently published book, entitled "Problems of the Panama Canal," has placed him in the front rank of the authorities upon the subject; Mr. Isham Randolph, chief engineer of the Chicago main drainage channel; Mr. Joseph Ripley, engineer of the Sault Sainte Marie Canal; Mr. F. P. Stearns, an eminent hydraulic engineer of Boston; Mr. Alfred Noble, past-president of the American Society of Civil Engineers; Mr. W. B. Parsons, of the New York Rapid Transit Commission; and Prof. William H. Burr.

The foreign members of the Board include men who have been most prominently associated with canal and drainage problems in Europe. Among them may be mentioned Mr. William Henry Hunter, of the Manchester Ship Canal, whose important articles in this Magazine six years ago attracted much attention; M. Edouard Quellenec, consulting engineer of the Suez Canal and engineer of the Corinth canal; M. Guerard, engineer of the St. Louis canal and of the Marseilles harbor improvements; Herr Eugen Tincauser, engineer on the Kiel canal; and Mynheer J. W. Welcker, director of the dyke and drainage system of the Netherlands.

In calling together such an eminent body of engineers the President has wisely raised the fundamental problems of the canal to an international position, and upon the decisions of these men the world may well depend, as representing the highest point in the present state of the art of the engineer. Quite recently the President called the Board to him at Oyster Bay, and there impressed upon them the importance of promptness in their work, and after their visit to the Isthmus an early and final report may be expected.

* * *

IN Mr. Wallaces's article in our September issue a few errata appeared—partly through oversight in the proof-reading, and partly through the lack of opportunity to receive the author's final revision before going to press. The following corrections are to be noted:—

Page 808, second line from top; after the word "removal" insert "from the summit cut."

Page 808, near bottom, first line under the sub-head "Bureau of Machinery"; for "Contracting the Design" read "Construction and Design."

Page 810, paragraph numbered 5, sub-head D; for "Division channels" read "Diversion channels."

Page 810, paragraph 5, sub-head I; for "Government of town" read "Government of Canal Zone."

REVIEW OF
THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

TELEGRAPH LINES IN AFRICA.

EXTENSIONS OF TELEGRAPHIC COMMUNICATION IN AFRICA IN CONNECTION WITH THE RAILWAY FROM THE CAPE-TO-CAIRO.

Hans von Hellrigl—Zeitschrift für Elektrotechnik.

IT is an interesting fact that in modern exploration work the telegraph not infrequently precedes the railway or even the highway. A wire can be run where a road is a difficult matter, and when a message can be sent it is frequently unnecessary for a man to make a journey. At the same time there is a curious sensation experienced when one realizes that before very long an overland telegraph line will be in working condition from one end to the other of the land once known as the "Dark Continent," but now rather the field of engineering development in nearly every. sense in which that broad term can be understood.

In a recent issue of the *Zeitschrift für Elektrotechnik,* Herr Hans von Hellrigl discusses the development of telegraph construction in Africa, and taken in connection with the article by Mr. J. Hartley Knight upon the progress of the Cape-to-Cairo Railway, which appears elsewhere in this issue, an excellent idea of the manner in which Africa is being opened up will be obtained.

When the through telegraph line was planned, in 1898-1899, it was hoped that the whole system would be in working condition by the close of 1904. This expectation has, unfortunately, not been realized, but at the same time excellent progress has been made. In May, 1900, telegraphic communication was open from the Cape as far north as Mafeking, a distance of 1,400 kilometers, while in the northern section the line was open from the Mediterranean southward as far as Fashoda, a length of about 3,500 kilometers. There thus remained to be constructed the connecting portion from the southern boundary of the Egyptian Soudan to Salisbury, the capital of Rhodesia. This stretch of about 6,000 kilometers in length was undertaken by the so-called "African Transcontinental Telegraph Company," an organization founded for the purpose by the late Cecil Rhodes.

As long ago as 1898 telegraphic communication had been opened between Karongo in Rhodesia and the northern extremity of Lake Nyassa, and the extension of 340 kilometers from Karongo to Abercorn, following the boundary between Rhodesia and German East Africa to the southern extremity of Lake Tanganyika was added in the early part of 1899.

The question which has here arisen concerns the carrying of the line northward through German territory. The railway connection, according to present plans, is intended to reach only to the southern extremity of Lake Tanganyika, traffic being carried from thence by steam navigation on the lake. The telegraph, however, must be carried either on the east bank, in German East Africa, or on the west shore of the lake, in the Congo Free State, after which the route to the Albert Nyanza and the Nile is in British territory. As long ago as March, 1899, Cecil Rhodes had an interview with the German Emperor upon the question of the construction of the line through German territory, but the matter

does not appear to have been definitely settled. At the present time the northern terminus of the line is at Ujiji, on the bank of Lake Tanganyika in German East Africa.

The construction of the telegraph line, so far as it has been executed, is a matter of some interest. The wires are carried on iron poles, these being usually 5 meters high, in three sections, the total weight being about 72 kilogrammes. Occasionally, when streams are to be crossed, or other wide spans cleared, there are higher towers constructed. Ordinarily the construction party was divided into five sections, the work being usually done by natives. The first gang cleared a way through the forest, staking out the location of the poles, usually about 13 to the kilometer, while the second partly followed and cleared and widened the path. The third gang dug the holes for the telegraph poles, while the fourth party brought the sections of the poles, these each forming a load for a man, and completed the work of erection. The fifth and last party carried the wires, and completed the stringing of the connection. By following this systematic procedure the work was rapidly conducted, when the natural difficulties encountered are taken into consideration.

The question of the extension of the British line through German territory is possibly complicated with the plans for a German line from Dar-es-Salaam, the German port on the eastern coast of Africa, to the interior of the colony, reaching to Tabora, and ultimately to Ujiji, thus connecting with the transcontinental system. It is possible that the final connection of the southern and northern portions of the entire system may be deferred until the construction of a railway line along either bank of Lake Tanganyika, in which case the telegraph line would naturally follow the railway route.

It is possible, however, in view of the constructive difficulties in this portion of the route, that communication may be opened between the present terminals by means of wireless telegraphy, at least over certain especially difficult portions of the route.

Other telegraph lines of interest and importance have been constructed in various parts of the African continent. Portions of what will ultimately be an east and west trunk telegraph line have been constructed, and these will unite the Congo Free State by way of Stanley Falls, with Abyssinia, where an extensive telegraph and telephone system is in operation, and from which three main lines connect to Egypt, to Erythrea and to French Somaliland, the latter line reaching the coast at Djibouti, on the Gulf of Aden.

A telegraph line naturally accompanied the construction of the Uganda Railway from Mombasa to the Victoria Nyanza in British East Africa, and this is being extended around to the west coast of the lake, the ultimate connection being to the main north and south line at some point not yet definitely settled, on the banks of the Albert Nyanza. Branch lines are also planned from the main line, eastward to Uganda, and westward to the Stanley Falls.

Numerous telegraph lines exist along the east coast of Africa, in connection with the Usambara railway, and in the territory of Portuguese East Africa and Mozambique. On the west coast a line follows the Congo river into the interior, and this connects to the submarine cable systems which are carried along the coast and places the region into communication with the telegraph lines of the world.

It is planned in the near future to connect the line of the Congo telegraph to Basaka by a branch from Equatorville, and an agreement has been made between France and Belgium for the introduction of a cable between Kiushassa, at the Stanley Pool on the left bank of the Congo, and Brazzaville on the right bank in French Congo territory. The cost of the cable connection is to be borne jointly by the two governments, and its construction will place the Congo country in direct communication with Europe through the lines from Brazzaville to Loango and Libreville and the coast cables.

The Sahara is now approached by telegraph lines from all sides, there being numerous spurs extending inwards from the various ports on the northwestern coast and from the French Mediterranean colonies. As yet the idea of a trans-Saharan telegraph is in the dim future and

it will probably be preceded by applications of wireless communication between a few stations.

From this brief sketch it will be seen to what a great extent the continent of Africa is being covered with a network of lines affording immediate telegraphic communication with points in the interior, and aiding in the exploitation and development of the whole land.

According to the report of the International Telegraph Bureau at Berne for 1903 there were then in operation in the continent of Africa 53,747 kilometers of telegraph lines, or about 33,400 miles, this being miles of route, representing many times that length of wire, while during the year 1904 there were added in Rhodesia alone 4,000 kilometers more, or nearly 2,500 miles.

DISASTERS TO SUBMARINES.

NOTES ON THE CAUSES OF ACCIDENTS TO SUBMARINE BOATS AND METHODS ADAPTED FOR THEIR SALVAGE.

Captain R. H. Bacon—Institution of Naval Architects.

ALTHOUGH there are various opinions at the present time as to the serviceability of submarine boats in actual naval warfare, there is no doubt that such vessels, in their present and in greatly improved forms, will form important portions of the navies of the future. Unfortunately the development of such vessels includes the necessity for many men to incur great risks in manœuvering and experimental manipulation, and there have been several such serious disasters of late to submarine boats in different places that the paper presented by Captain R. H. Bacon before the Institution of Naval Architects upon the causes of such accidents, and the best means of conducting salvage operations is especially timely.

Captain Bacon recognizes at the start that questions of public policy forbid the discussion of full details of construction and operation of submarines, but there are certain well-known principles of construction necessarily involved in all types, and bearing these in mind the subject can be examined intelligently.

"Broadly speaking, there are two classes of accidents that can happen to a submarine boat. First, the admission of water into the interior; secondly, an explosion. Both these have their counterpart in surface vessels, namely, collision and boiler or ammunition accidents. But the confined space and small reserve of buoyancy of the submarine boat intensifies the danger of the result to the crew. And it is this, rather than the frequency of accidents, that has occasioned public comment.

"In the case of admission of water, no help can be expected from water-tight bulkheads, for obviously to keep the vessel afloat each compartment must not have a greater capacity than the equivalent of the reserve of buoyancy; but, further, for such compartments to be effective, only one, namely, the center one, can be allowed the same volume as the reserve of buoyancy, since it is not only necessary to float the boat, but also to afford egress to the crew, and, therefore, the boat must be maintained approximately on an even keel. To do this no compartment except the midship one must exceed in capacity half the reserve buoyancy of the boat; this limitation is necessary so as to allow of a corresponding compartment, the opposite end of the boat being flooded to maintain the horizontal trim. Such subdivision would mean at least thirty compartments, and none except the one in the center of the boat could be more than 3½ feet between the bulkheads. Of course such a subdivision is an impossibility. It may, however, be argued that it would be well to have one or two compartments so as to confine the water to definite portions of the boat, and to leave a certain amount of space for the crew to inhabit in case of accidents. This is a very reasonable contention, but before accepting it we must consider the probabilities of an accident happening, the chances of such an accident occurring in waters where salvage is possible, and, further, the chances of successful salvage to save life under ordinary conditions of sea and weather; all these must be balanced against the ever

present inconvenience in daily life of having the boat divided into these three or four compartments. Such subdivision is not merely an inconvenience as regards control and communication, but for another reason it reacts against the efficiency of the boat when actually running on service. One marked feature in practice is the way in which spaces below a certain size affect the normal mental condition of the men. To run a boat successfully everyone inside her should be in an absolutely normal condition; the increased construction of vision and the necessary accuracy of handling argue even greater coolness than in ordinary vessels. For a man's mental condition to be normal, free living space is required; too confined surroundings react on the crew, and by producing a feeling or restriction create a mental tension; hence unless some very strong reasons exist for making living spaces below more confined than absolutely necessary they should be as large as the boat will permit."

In considering the case of accident by water entering the boat, this may occur when the water enters a hatch, or when it gains access by a leak, the former being the more probable cause. All the recent accidents, those of the Russian *Delfin*, the French *Farfadet*, and the British A 1 and A 8, were due to this cause, and it is to this point that improvements in design should be directed. Automatically closing hatches have been suggested, but while such a construction is possible the danger of any portion of a man being trapped by the closing hatch would entirely nullify and security.

Probably the best protection is the provision of improved methods for enabling the hatch to be closed or tightened from within, with possibly the addition of a supplementary hatch at the base of the conning tower.

Dangers from collision cannot always be avoided, but care in manœuvering may greatly reduce their probability. It is naturally one of the dangers to such boats when in action; in common with practically all other types of war vessels.

So far as accidents from explosions are concerned, these may be caused by the formation of explosive mixtures of petrol and air, due to leaks; or to the accumulation of explosive gases from storage batteries. Captain Bacon also mentions explosions of compressed air reservoirs, and the possible danger from a flooded storage battery. These accidents may be considered as preventable by care in construction and in operation, although the danger of explosion of petrol vapor may be removed by the employment of motors using heavy oils, such as the Diesel motor, which, we believe, is used in certain submarines. Broadly, the danger from explosions is no greater than on board any ordinary naval vessel.

In regard to salvage problems, Captain Bacon discusses primarily the question of saving the imprisoned men, since a boat itself can generally be raised afterwards, sufficient time being given.

"Before adopting any special appliance or constructional complication, suggested solely from the point of view of saving life in accidents, two considerations should be fulfilled: First, the fighting efficiency of the boat must not be seriously affected by it, since the boats are designed primarily for fighting and not for meeting with accidents; and, secondly, that such arrangements when introduced shall be efficient against all reasonable accidents that may happen. It is simple to design a boat to be safe against any particular accident; the impossibility lies in designing one safe against every accident. The commonest device for the release of a crew from a boat is that of providing an air lock and diving chamber, and a hatch that can be opened from the bottom of the air chamber, the pressure of air preventing the water entering when the hatch is open; the crew can then, one by one, dive out and come to the surface. Supposing a sufficient space devoted to such an arrangement, there are two considerations which militate against its success. The hatch must necessarily be in the bottom of the boat, but if an accident happens it is "even chances," even in the uncommon case where the boat is undamaged, whether the boat rests with its fore or after end on the bottom. It is, therefore, an even chance whether the men would, or would not, be able to use this means of egress. Again, it must be assumed that water is present in the boat, otherwise there is no reason that she should

not come to the surface, and if this water is present it is again an even chance if the compartment can be got at from the interior of the boat. But further, even supposing this chamber could be used, we have still to consider the effect on the crew of the variation in pressure by suddenly rising to the surface from a considerable depth. It is common knowledge that under pressure the gases absorbed in the blood get compressed, and that sudden release of such pressure allows them to expand, producing large bubbles of gas in the blood, which cause breaks in its continuity; this is productive of the most serious effects on the system, so that, even if the men were able to find egress, in many cases their lives would not be saved. Since, therefore, this system cannot be safely used in deep water, not at all on a soft bottom, and unless duplicated and placed at each end of the vessel, it is useless with a small amount of water in the boat, and quite valueless with a large amount, it is not a fitting on which it is worth wasting much valuable weight and space. Another common suggestion is to provide a detachable chamber into which the crew may climb, which can be freed, and then will float to the surface. A few figures will dispose of the practicability of this idea. Allowing 1½ square feet of space for each man, 11 men will require 16½ square feet. If the chamber were made cylindrical the thickness would be ¼ inch. It would have to be ballasted to keep it upright when floating, and, moreover, must float with a certain reserve of buoyancy to allow of the top being open even in smooth water for the egress of the men. This means that the cylinder would have to be at least 6 feet in diameter, and 7 feet to 8 feet high. This would be an enormous excrescence outside the boat, and greatly increase her submerged resistance, even if further fitted with fair waters to relieve its circular shape, although increasing its size. Its dimensions would quite preclude the possibility of carrying it inside. In addition, the securing arrangements and water-tight doors would add considerably to its weight, and then, in the end, a collision, which is, after all, the most probable cause of accident, would be liable to put it out of gear. Any one who really considers carefully the difficulties of providing reasonable methods of exit for a crew will soon be convinced of the futility of such special arrangements."

SUBWAYS IN CHICAGO.

CONSTRUCTION AND OPERATIVE FEATURES OF THE FREIGHT AND TELEPHONE TUNNELS IN CHICAGO.

Report of the Special Commission.

THERE has been recently much interest expressed in the discovery by the general public and by the municipal authorities that a private corporation has succeeded in constructing more than thirty miles of tunnels beneath the streets of the city of Chicago, and in order that the status of the work might be officially determined a special commission was appointed to investigate the matter. This commission has made a report which contains much matter of interest and some abstract and comment upon the subject may be permitted.

Ostensibly the tunnels were intended to be used merely for the purpose of carrying the wires of the Illinois Telegraph and Telephone Company, and under an ordinance passed in 1899 work was begun. The section of the tunnel was given as 6 feet wide by 7 feet 6 inches high, in horseshoe form, this size being adapted for the passage of workmen and the placing of the wires in position. The company had acquired the control of the patents of the Strowger automatic telephone system, and that system is now in practical operation in Chicago, using the tunnels which have thus far been constructed. In 1901 larger trunk-line tunnels were started, these being 12 feet 9 inches wide by 14 feet high, this section being permitted in order to enable the larger cable reels to be introduced into the system, and avoid interference with the streets and with other underground work. Only a short section of this enlarged tunnel has been constructed, but of the smaller size there have been con-

structed more than thirty miles, underlying the greater part of the business districts of the city.

"The tunnels are constructed of concrete, 10 inches thick on the crown and sides and 13 inches thick on the bottom. All the main lines, including many of the bypasses and curves at the intersections, were constructed under an air pressure of about 9 pounds. The method of construction was as follows: The bore was dug in the clay for a distance of 20 feet, and about a foot larger all around than the completed tunnel was to be. The 13-inch concrete bottom was then put in place, and on this were placed forms made of 5-inch channel bars in two pieces, and curved to the exact size of the inside of the completed tunnel. Outside of these forms, boards 20 feet long were placed one at a time on each side, and the concrete rammed into the space between the boards and the clay. When the crown forming the key was reached, boards 3 feet long were used. It was afterwards found better to build 15-feet sections instead of 20-feet. The concrete was composed of one part Portland cement, 3 parts sand and 5 parts gravel."

Although, as has been stated, the tunnels were originally intended for the purpose of constructing a telephone system, it was found that the size of the section permitted room for small cars and electric locomotives, and after a considerable portion of the work had been completed, the company announced that it was prepared to undertake the carrying of merchandise, newspapers, mail matter and similar work. At the present time the system is in a position to deliver and convey merchandise to nearly al parts of the business portion of the city, to deliver and remove ashes from power plants, convey baggage from railway stations to distributing points, in short, to relieve the streets of Chicago from a large part of the congestion of the present trucking system, and probably to enable many of the labor troubles inseparable with that system to be eliminated.

The manner in which the work was done is remarkable, in that there was no disturbance of the public highways, the original shafts being dug in the rear of private buildings controlled by the individuals interested in the project, and the tunnels being excavated through the clay which underlies the city, at a depth of about 30 feet, the earth being brought up through shafts at various points and removed at night, so that the magnitude of the work which was going on beneath the streets was not brought conspicuously to the attention of the public.

The method proposed for the operation of the tunnel system for freight transportation is to construct shafts down to the tunnel from the buildings to be served, these shafts being sufficiently large to enable the small cars to be raised to the basement or sub-cellars of the buildings upon elevators. Empty cars may thus be brought up and full ones lowered, and transferred to any part of the city and raised again, and a systematic delivery and hauling business conducted.

Now, after all this work has been done, it is somewhat amusing to find that the official mind is deeply disturbed by these proceedings. In a manner which may be considered as wholly unauthorized these industrious civilians have actually finished a subway system without spending years in discussing plans and schemes, and without interfering at all with other people's business. One is reminded of the criticism of the old military martinet upon the campaigns of the first Napoleon.

"In our day," said he, "we used to march and countermarch, and then we went into winter quarters. Now here comes along a young man, not yet thirty years old, who fights battles in December! 'Tis unheard of."

So with the presumptuous builders of the Chicago freight subways. They have actually ventured to devise and execute a great public work, of which Chicago was sorely in need, far within the time which would have been possible with any unwieldy commission, operating according to beaucratic methods, and the circumlocution offices of Chicago are horror stricken.

All this must now be remedied. It is indeed impracticable to fill up the tunnels and start all over again, but something must be done to call these industrious benefactors of Chicago to account.

"The commission has not been able to

find any authoritative statements concerning capacity of the tunnels to carry the amount of freight claimed, the proper speed for trains, the safe regulation of grade crossings, etc. These questions have not as yet been determined by the company and very probably will not be settled until demonstrated by actual practice. It considers this entire matter should receive the most careful investigation and consideration of competent railroad men.

"It is a matter of great concern to decide how these tunnels shall be regarded, whether as public highways or as the premises of a private corporation. On the point of view taken by the city will depend the solution of the problem of safeguarding the public or employees of the company against crime, accident, fire, breaking down of power and light plants, etc. There is no provision for emergency exits from the tunnels in case of accident.

"The control and supervision by the city of the work of building these tunnels has been lax when compared to similar work done for private individuals or corporations. Ordinary practice demands a definite official plan and specification, and a sufficient force to properly supervise the work at all points and at all times; while in this case there were no definite plans and specifications, and there was but one city representative in the supervision of the entire work. The commission finds the city records of the work very incomplete, for example, it has been unable to find any written specification either for the cement or the concrete. It has been unable to find any official survey showing the exact location of the tunnels."

While these solemn proceedings have been ponderously getting under way the tunnel builders have been busily at work, and unless the commission can get its work in very promptly there will be a much greater extent of tunnel construction completed than when their deliberations were begun. It is to be hoped that nothing will really be done which can effectually block the full completion of this most important enterprise, and the only matter for regret is that similar methods of rapid and quiet construction cannot be carried out in other great cities, to the great benefit of the public and the ultimate discomfiture of the ancient and unscientific system which depends upon the use of heavy trucks on the surface.

THE CAUSE OF BRITTLENESS IN STEEL.

INVESTIGATIONS INTO THE INFLUENCE OF COMBINED NITROGEN UPON THE PHYSICAL PROPERTIES OF IRON ALLOYS.

Hjalmar Braune—Revue de Métallurgie.

AMONG the various physical and mechanical properties of the numerous iron alloys grouped under the generic name of steel, that of brittleness, or as the French call it, fragility, has caused much perplexity. Two products, apparently the same in chemical composition, and in visual constitution will be found to be quite different in behaviour under shock, one being tough and resistent while the other breaks without warning. Attempts to devise physical tests to discover the causes of this action, or at least to separate the good material from the bad, have met with but partial success, although various forms of drop tests are now realized to be of much value in commercial investigations. Examinations of portions of structures which have failed in service have not given any very clear indications as to the causes of sudden breakages, and it has been felt that some better knowledge of the origin of the property of brittleness would have to be discovered before the practical side of the subject could be pursued further to any material advantage.

We now have a paper in the *Revue de Métallurgie,* by M. Hjalmar Braune, giving a theory of brittleness based upon his investigations of the past six years, this paper being of a preliminary nature, and to be followed by a more detailed account of the experimental researches upon which it is based.

Briefly, M. Braune maintains that brittleness is due to the presence of combined nitrogen, taken up by the iron during various stages of its manufacture. The nitro-

gen appears to be combined entirely with the iron itself, with the ferrite, forming what may be called a nitrogenized iron; the carbides such as the cementite being entirely free from any nitrogen. This nitride of iron appears as a solid in solution in the ferrite, and acts to lower its point of fusion and at the same time diminishes its capacity for dissolving carbides of iron. In this way the nitrogen exerts a marked influence upon the quality of the metal, whether it be a soft iron, or a hard steel or cast iron.

These statements may be proved by a few simple experiments. A test piece of iron or steel of the highest quality is placed in an atmosphere of ammonia, and raised to a temperature of 800 degrees C. for a period more or less prolonged. These pieces are then annealed in sand, to permit the combined nitrogen to become homogeneously distributed through the metal. The behaviour of pieces thus treated, when tested, shows very clearly the influence of the nitrogen upon the resistance. When the content of nitrogen reaches 0.07 to 0.08 per cent. the elongation rapidly diminishes, and becomes discontinuous, while for higher percentages of nitrogen the ductility of the metal practically disappears. In some instances the surfaces of the test pieces became covered with fine cracks, these effects appearing in pieces in which the annealing had not been sufficiently prolonged, so that the greater portion of the nitrogen remained near the surface.

The effect of the presence of the nitrogen may also be observed by making a metallographical examination of the test specimens. The original untreated metal showed a constitution composed of large cells of uniform surface. Under the presence of nitrogen the appearance of these cells becomes modified, parallel striae of corrosion appearing, while the dimensions of the cells continually diminish. Some of the cells retain their original appearance, while others become completely granulated. Some are partly modified and it is possible to perceive the manner in which the passage of the degradation from one cell to another is resisted. When the content of nitrogen approaches 0.07 to 0.08 per cent. the cells become very small, scarcely one-tenth of their original size, and at the same time the cement which fills the separating spaces between them increases in thickness. When this structure is developed the metal has become wholly brittle. If the nitrogen content attains 0.2 per cent. the cellular structure wholly disappears and appears only a series of dark lines, giving a more or less characteristic pearlitic aspect.

The cellular structure appears to bear a distinct relation to the ductility of soft iron. The larger the cells, the more ductile the metal. The cement which forms between the cells contains the impurities in the metal. A content of nitrogen as high as 0.07 per cent. very rarely appears in commercial products, but in very soft irons, particularly in the products of Lancashire, a very much lower percentage of nitrogen will suffice to render the metal hard and brittle.

The influence of nitrogen upon hard steels is also very distinct. M. Braune discusses the behavior of a steel containing 1.15 per cent. of carbon, when given increasing quantities of nitrogen by heating in an atmosphere of ammonia. At first there is a slight increase in resistance and reduction in elongation; then, suddenly, between 0.03 and 0.035 per cent. of nitrogen, the elongation disappears entirely, the metal becomes completely brittle. For a steel containing 0.50 per cent. of carbon the critical proportion of nitrogen corresponding to the disappearance of ductility is 0.040 to 0.045 per cent., while for a steel of 0.02 carbon this effect is produced by 0.050 to 0.060 per cent. of nitrogen. In every case the sudden attainment of brittleness corresponds to a change in the structure.

A percentage of 0.060 nitrogen is very rare in commercial steels, but 0.030 to 0.040 per cent. frequently appears. For this reason hard steels become brittle much more easily than softer grades, since the proportion of nitrogen required to cause the effect occurs more frequently in practice.

Nitrogen appears also to produce a considerable effect upon tempered steels. The nitride of iron in such cases, appears in solution in the martensite, as it does in the ferrite for the annealed steels. The in-

fluence of nitrogen upon the electric and magnetic properties of steel is also distinct. In the case of soft iron the coercitive force and the hysteresis are increased.

In commenting upon these remarkable researches of M. Braune, M. Le Chatelier observes that their importance will be evident to every metallurgist. The appearances noted in the metallographic observations of M. Braune have been noticed before, but it has remained for him to discover their origin. An interesting fact is that the fixation of the nitrogen by the iron does not occur directly by a combination with the nitrogen of the atmosphere, and the presence of a basic slag appears to be necessary as a reducing medium. This corresponds closely with the process of the formation of the cyanides, and indeed it has already been observed that blast furnaces which produce much cyanide of potassium also produce an inferior quality of iron. The nitrogen is acquired by the metal principally in the blast furnace and in the basic converter.

The experiments of M. Braune show that the fixation of the nitrogen is effected more readily from ammonia than from the cyanides. The ease with which the cyanides are transformed into ammoniacal compounds in the presence of moisture renders it probable that the vapor of water may be an intermediary in the introduction of the nitrogen into the metal. This view is confirmed by the experience of M. Guillet in the cementation of nickel steel, it appearing that the use of a moist cementing material is injurious. With a dry material for the cementation the interior of the case hardened pieces shows no brittleness, which is not the case with a moist substance.

The importance of these studies cannot be over-estimated, and if, as appears probable, M. Braune has discovered the true cause of brittleness in iron and steel, the way to prevent the combination of nitrogen with the metal will doubtless be found by practical metallurgists and manufacturers. After the way has been blazed, every succeeding traveler broadens the path, and in this, as in other departments of applied science, the operative departments of an industry are prompt to avail themselves of the discoveries which are made in the laboratory. If the cause of brittleness has actually been discovered, its removal is only a matter of time, and the far-reaching consequences of the discovery cannot now be limited.

HYDRAULIC POWER OF THE APPALACHIAN REGION.

POSSIBILITIES IN THE HYDRO-ELECTRIC DEVELOPMENT OF THE WATER POWERS OF THE SOUTHERN SECTION OF THE UNITED STATES.

Dr. F. A. C. Perrine—American Institute of Electrical Engineers.

AMONG the discussions of natural resources which are now so general in progressive countries may be noted the valuable analysis of the available water power existing in the southern part of the United States, presented as a paper before the American Institute ot Electrical Engineers by Dr. F. A. C. Perrine, and some abstract of this article is given as bearing upon a subject of much importance.

The watershed from which the hydraulic power is derived, belonging broadly to the Appalachian region, includes the Shenandoah, Greenbrier, Blue Ridge, Black, and Great Smoky mountains. Here the rainfall ranges from 35 to 60 inches, there are no difficulties from ice or snow, and there is a well defined fall line above which, in the mountain region, there are numerous opportunities for high heads, while between the fall line and the mountains lower heads are available. By the introduction of modern hydraulic and electrical machinery these sources of power may be developed and applied for manufacturing industries, mostly in connection with the work of their immediate vicinities, thus avoiding the cost and inconveniences of long-distance transmissions, besides aiding in building up the sections in which they are located.

"The principal rivers of the Southeastern Appalachians whose drainage basins

need to be considered are the James, Roanoke, Staunton and Dan rivers, in Virginia; the Cape Fear, Yadkin and Catawba, in North Carolina; the Catawba, Broad, Saluda and Savannah, in South Carolina; the Oconee, Ocmulgee, Flint and Chattahoochee rivers, in Georgia, and the Talapoosa, Coosa, Tuscaloosa and Tombigbee rivers of Alabama. There are many tributaries and some of the rivers change their names from source to mouth.

"The northernmost region selected for study is the drainage basin of the James River, having at Richmond an area of about 10,000 square miles. This river gathers its waters from streams flowing northeasterly and southwesterly among the Allegheny, Shenandoah and Blue Ridge Mountains and carrying them entirely across the State of Virginia in a general easterly direction empties them into Chesapeake Bay. The fall line is not reached till at Richmond, where there is an abrupt descent of 84 feet to the tide level just below the city. The James drains an old, well cultivated portion of the country, having an average rainfall of about 41 inches. The minimum run off is 0.20 second-feet per square mile, and the maximum 20 second-feet. An average of 0.35 second-feet may be expected over a three months' period. Toward the headwaters the variation of flow is even greater than nearer the mouth, on account of the fact that the mountains here are low and little snow falls upon them, and they are largely denuded of trees. The average fall of the James from Richmond to the headwaters is about 4.25 feet per mile, excluding the sharp fall at Richmond; in consequence of this rapid flow, exhibiting many opportunities for power development, as the fall is uniformly distributed along the river.

"The Cape Fear River drains a region in the center of North Carolina. Although the watershed is principally covered with clay and sand and comprises pine and oak forests and agricultural land, and in spite of the fact that there are no great falls in its course, except at Smileys Falls, still it is one of the most completely developed power rivers of the South. The rainfall over this watershed averages 50 inches, the greatest fall being in the spring and summer. The monthly average run off is not more than 0.12 second-feet. On the other hand, the floods are very severe, running from as high as 15 second-feet in May to 20 second-feet in January. That a stream with these difficulties to be encountered should have been so well developed shows plainly the importance of a ready market in problems of power development, and the effect of even an unreliable water power in developing manufacturing in a country where the conditions of market, raw material and unsatisfactory labor are favorable.

"The Yadkin River of North Carolina, or the Great Pedee of South Carolina, drains above where it crosses the fall line at Cheraw, S. C., a territory of about 9,700 square miles. Except in the rapids at Cheraw and at the Yadkin Narrows, 55 miles above, there are no important falls, though there are on the watershed a number of opportunities for development by high dams forming storage reservoirs. The rainfall in the mountain region along the headwaters of the Yadkin averages in excess of 55 inches, but over the greater portion of the watershed it amounts to about 46 inches. For the average year the run off is at a rate no lower than 0.32 second-feet. The floods frequently run as high as 30 second-feet, but with few monthly averages rising above 5 second-feet per square mile. The course and drainage area of the Catawba are much similar to those of the Yadkin. Near Camden, S. C., it crosses the fall line; just above are not only the customary rapids, but a few miles further north one of the most remarkable power sites in the South, a total fall of over 150 feet being available for development.

"The fall of the river is not so gradual as the Yadkin, but concentrated in falls, many of which are available for developments of considerable size. The drainage area at Camden is about 5,000 square miles; in the upper half of this territory the rainfall averages about 50 inches and in the lower half about 45 inches. Almost the whole territory is heavily wooded and in consequence the run off is comparatively uniform.

"West of the watershed of the Catawba lies the Broad River, which rises in the Blue Ridge Mountains east of Asheville and flows southeasterly to Columbia, where it joins the Saluda to form the Congaree.

The latter flows into the Wateree and forms the Santee. There is no point at which the Broad crosses the fall line, but it lies altogether in the uplands. The slope is great, averaging about 4.5 feet per mile for 140 miles from its mouth. A number of favorable opportunities are presented for development, notably near Alston, S. C., and near Gaffney, S. C. The drainage area at Gaffney is approximately 2,000 square miles and at Alston about 4,600 square miles; the total drainage area of the watershed is about 4,900 square miles. The soil over the watershed is generally sandy and a large portion is wooded; in consequence the run off is well distributed, not having been found to fall below 0.35 second-feet per square mile.

"The Savannah River, which at Augusta drains a territory of about 7,300 miles located almost equally in South Carolina and Georgia, promises to become the source of some of the most important water powers in the South, not only because the stream flow is good and the shoals well adapted to development, but particularly from the favorable economic situation of the water power sites. The territory on both sides of the river is an important cotton growing section and its adaptability for mills has been well proved; in fact, Augusta, Ga., is the largest cotton manufacturing city in the whole South. The industries of that city have been built up about a 50-foot fall in the Savannah, at that point where the river crosses the fall line. The minimum flow will run as low as 0.50 second-feet for from four to six months. The maximum is about 25 second-feet.

"The middle portion of the State of Georgia is drained by the Oconee and Ocmulgee, which at Milledgeville and Macon, respectively, cross the fall line—a territory of about 6,000 square miles. The rivers are comparatively steep and present a number of opportunities for power development. The flow is comparatively low, often during several months of a year falling to as low as 0.2 second-feet. The maximum flow of 20 second-feet occurs in the spring.

"To the southwest lies the drainage area of the Flint River which crosses the fall line at Albany and follows the Blue Ridge Mountains practically to the end in a rapid flow. This river presents the anomaly of frequently being at its lowest during November, a great disadvantage in a power river, as the yearly load curve of most industries is generally rising at that time.

"The last four watersheds described are headed in the Blue Ridge Mountains which run southwest through Georgia. Across the mountains and running parallel to them is the watershed of the Chattahoochee River which runs rapidly down between the lower extensions of the Blue Ridge and Great Smoky Mountains. In consequence of being located almost entirely in the mountains it presents many desirable characteristics as a power stream. The minimum run off falls to a rate of 0.25 second-feet, and the flood is about 20 second-feet."

ELECTRIC SMELTING.

A DISCUSSION OF RECENT PRACTICAL ADVANCES IN THE ELECTRO-METALLURGY OF IRON AND STEEL.

R. S. Hutton—Society of Chemical Industry.

WITH the development of electro-metallurgical processes in other parts of the world the possibility of applying the methods of electric smelting of iron and refining of steel to the industry in Great Britain is attracting attention. In a paper recently presented before the Manchester section of the Society of Chemical Industry Mr. R. S. Hutton shows that the position of England in this respect is by no means so discouraging as some would believe. Incredulity in this respect is largely based upon the fact of the limited water power available, but it must not be forgotten that the power cost is but one element, and not always the controlling one.

"Many leading electrical engineers have published minute data as to the cost of power generation, but only for electric lighting, traction and motor purposes. These cases, however, are so entirely different in character from those we are concerned with that no definite conclusions can be drawn from this evidence. The

average power station is fortunate to get a 15 per cent. load factor and overjoyed with 30 per cent., whereas in nearly all electro-chemical works the manufacture is continued night and day throughout the year, and the load factor may be taken as 100 per cent. If one may judge from the evidence of those few who have had actual experience in electro-chemical industries using steam power, a figure of £6 to £8 for the horse power year is quite attainable under such conditions. With producer gas this may probably already be brought down to £4 in Great Britain. For the sake of comparison, it may be pointed out that although in some few places in the Alps and Norway a figure as low as 17s. per horse power year has been attained, water power is very seldom to be obtained so cheaply. At Niagara the price of supply to large consumers varies from £3 11s. to £4 3s. and at Rheinfelden reaches £6 for the horse power year.

"So far as blast furnace gas is concerned, no very sure data are available for similar industries. The supply of cheap gas power is likely to prove so beneficial to Great Britain in the application of the industries we are about to consider that it is earnestly to be hoped that those who are concerned in the construction of large gas engines will be led to take an interest in these developments. With their co-operation the number of remunerative electro-chemical industries may be very largely increased in England."

There does not appear to be any immediate probability of the introduction of electric methods for the reduction of iron from the ore, but Mr. Hutton gives some interesting points about the relations of electro-thermic processes to the present smelting methods.

"The application of the electric furnace to the metallurgy of iron, with the exception of some few small-scale experiments, which are more of historical than technical interest, may be said to be largely founded on the experience gained in the manufacture of calcium carbide. Carbide furnaces have been and are being largely used for the production of rich ferro-alloys such as ferro-chromium and ferro-silicon, and in this way electro-metallurgy has already been of considerable service to the steel industry. As the production of calcium carbide became less and less remunerative, and as the demands of the market for these ferro-alloys became satisfied, definite attempts were made to tackle the problem of the direct reduction of iron ores.

"It might seem to be rather a hopeless task which the electro-metallurgist has thus set himself; for direct competition with the blast furnace is obviously out of the question so far as our own and probably all other present iron-producing countries are concerned. On the other hand, there are certain advantages which can be gained by electric heating, and, although the electric reduction of iron ores is at the moment unremunerative, we may expect to hear more of it in the future, when the general development of electric furnace construction is more advanced.

"Every ton of pig iron produced in the blast furnace requires very nearly one ton of coke for its production. Of this amount only one-third is necessary for the chemical reduction of the ore, the balance being employed in producing and maintaining the requisite temperature. This two-thirds of the fuel supply can be replaced by electric heating.

"In actual practice, so far, only the simple case of reducing the ore and allowing the carbon monoxide to pass away unused has been tried. Various methods have, however, been proposed by Héroult, Harmet and others for utilizing the total heat of combustion of carbon. Under these conditions it should be possible to reduce iron ore with a much smaller power expenditure. The perfecting of methods along these lines is a matter for the future."

In considering the question of the electric production of steel the matter should be examined on its own merits, and not in connection with the ordinary processes. So far as the matter of power is concerned, the results of the investigations of the Canadian commission show the power expenditure per 1,000 kilogrammes of steel to range between 500 and 1,000 kilowatt hours, the lowest expenditure being that of the Kjellin induction furnace, which was charged with molten pig and cold scrap, while the largest power expenditure occurred when the charge was cold.

More important than the power consumption, however, is the quality of the

steel produced by the employment of electric refining processes.

"In the first place, there seems to be good evidence to show that steel, equal in quality to the best Sheffield crucible steels, can be produced in the electric furnace. This can be accomplished either in such a furnace as that of Kjellin which, in its present form, is used almost entirely for melting up carefully-chosen raw materials, and does not rely on any considerable refining of the material. On the other hand, with the Héroult furnace such a product can be obtained starting with almost any grade of raw material; this process relying essentially on its capability of rapidly and completely refining pig iron or ordinary scrap steel. The economical advantages of using a cheap grade of raw material for producing high quality crucible steel will doubtless tell in favor of such a method. It is largely to such possibilities of refining and to the relatively high cost of fuel per ton of product for the manufacture of crucible steel, that the electrical processes owe their advantages.

"From the investigations of the Canadian commission it appears that in nearly all cases the whole operation of melting and refining the raw material has been effected by electric heating. In Great Britain where coal is cheap it is almost certain that much of this heating could be more economically carried out by the combustion of fuel. In the case where molten iron or low grade steel can be run into the electric furnace it will be seen that the power expenditure required for refining it and bringing up its quality to that of a crucible steel is indeed very low. Along such lines as these, the electric furnace may be expected to find still wider application than to the manufacture of high grade crucible steel."

THE METALLURGICAL CONGRESS AT LIÉGE.

RECENT DISCUSSIONS OF CURRENT METALLURGICAL PROBLEMS IN CONNECTION WITH THE LIÉGE INTERNATIONAL EXPOSITION.

Leon Guillet—Le Génie Civil.

WE have given elsewhere in this issue a fully illustrated account of the engineering features of the international exposition now being held in Liége, Belgium, and, following the custom usual with such exhibitions there have been held various technical congresses and scientific gatherings, concerning which reports are now beginning to appear. In recent issues of *Le Génie Civil* is given an excellent summary of the proceedings of the Congress of Metallurgy, from the pen of the well-known metallurgist, M. Leon Guillet, himself an active contributor to the work of the congress.

The congress, which was attended by about 1,600 delegates, including some of the most eminent metallurgists and engineers from Belgium, France, Germany, England, etc., had its work divided into five departments, treating of groups of metallurgical work. The first section considered problems relating to large operations, such as the manufacture of pig iron and of steel, the production of power from furnace gases, the utilization of slag, etc. The work of the second section related to special methods and progresses, such as the manufacture of alloy steels, electrometallurgical processes, and the like. In the third section there was discussed the treatment of iron and steel products, such as the heat-treatment of steel, and the effects of rolling and mechanical working of the metal. The fourth section was devoted to the study of metallography, while the fifth took up processes having an indirect relation to metallurgy, such as the brazing and welding of metals, etc.

It is impracticable, within the space here available, to comment upon all the papers submitted before the congress, but some of the more important communications may be noticed. Thus M. E. Bian, the director of the iron works at Eich, in Luxemburg, described the method which he has found satisfactory for purifying the gases from blast furnaces, rendering them suitable for use in gas engines. This apparatus consists of a cylindrical chamber filled half full of water, and containing a shaft carrying a number of disks of metallic netting,

these disks being kept in constant rotation. The gas, passing through these, parts with its dust and other matter in suspension, and the disks are continually washing themselves in the water, this latter being constantly renewed.

An interesting matter in connection with the work of the first section was the discussion of the Gayley dry-air blast for blast furnaces. The correctness of the theory of the process is fully borne out by the facts developed in the discussion. Thus a table prepared by M. Divary, of the Creusot works, shows that the fuel consumption of a furnace under his observation bore a close relation to the hygrometric condition of the atmosphere. Taking the fuel consumption in January as a base, there being 6.3 grammes of water per cubic meter of air, and the daily production of the furnace being 90 metric tons, there appeared in July, when a cubic meter of air containing 13.6 grammes of water, an excess consumption of 133 kilogrammes of coke, while the output of the furnace fell to 70 tons per day. The results for other months showed a close correspondence as to the variation in coke consumption and in iron production with the variation in the proportion of moisture in the air, these figures agreeing closely with those observed by Mr. Gayley at Pittsburg. It is intended to introduce the refrigerating process of drying the air at the Creusot works, as well as in other establishments in Belgium and Germany.

In discussing the theory of the dry-air blast, M. Le Chatelier showed the injurious action of moisture in the air in connection with the presence of sulphur in the iron. By the use of air which is free from moisture any sulphur which is present is converted into sulphurous anhydride, which is entirely absorbed by the limestone in the upper zones of the furnace, where iron itself has not yet reached the spongy condition in which it can take up the gas. The sulphur thus passes off entirely in the slag, a condition which does not occur in the presence of moisture.

The much disputed subject of slag cements came up for discussion at the congress, and Prof, Wedding, of Berlin, expressed himself of opinion that slag Portland cement, made by re-calcining and grinding briquettes made of granulated slag and lime, does not differ chemically from ordinary Portland cement, while the results of mechanical tests are entirely comparable.

Passing to the work of the second section, this included discussions upon special alloy steels, M. Guillet himself furnishing a classification of these products, according to the manner in which the added metal combines with the iron and with the carbon. M. Guillet gave several diagrams showing the influence of the different constituents upon the properties of resistance to rupture, to shock, to elongation, and upon hardness, these enabling a general idea of the effects of the various constituents to be determined and compared. Referring to the ternary steels, these including those containing iron, carbon, and one other constituent, M. Guillet says that the nickel and the manganese steels may sometimes take the place of carbon steels; that the polyhedric steels should have an important industrial future, if the price can be brought sufficiently low; that the tungsten and molybdenum steels have shown themselves of great value for high-speed tools; and that there is apparently no practical use for the graphite steels.

So far as the interesting subject of electrometallurgy is concerned, the principal point brought out at the congress was the fact that the well known projectile works of Jacob Holtzer, at Unieux, has put into service a steeel refining furnace of 1,000 kilowatts, capable of producing 7,000 to 8,000 kilogrammes of steel at a charge.

In connection with the works of the section devoted to processes of treatment of iron and steel, mention may be made of the researches of Hadfield upon the effects of low temperatures upon alloy steels, already noticed in these columns; and of the paper of M. Creplet, upon the application of electric power to the driving of rolling mills.

Of especial importance was the paper of M. Le Chatelier, in the fourth section, upon the subject of metals and alloys by the methods of metallography. M. Le Chatelier discusses the methods of polishing the surface of the metal to avoid surface hardening, describing the preparation of the emery and alumina for working the sur-

face, and the use of various solutions for etching the polished metal. The use of picric acid, originating in the laboratory of M. Le Chatelier, is now well known, but a later method in the use of heated saline solutions containing an oxidizing substance. By using a 25 per cent. solution of caustic soda with 2 per cent. of picric acid, heated to 100 degrees C., the cementite is attacked, without any action being produced upon the other constituents.

In the production of the microphotographs M. Le Chatelier prefers the Nernst lamp to the mercury arc, and the details of his microscopic apparatus have been worked out with great care. After all the care which can be taken, much depends upon the skill and judgment of the operator, and in this, as in other departments of investigation it is impossible to be assured of uniform results.

In the auxiliary metallurgical subjects attention was directed at the congress to the use of the oxy-hydrogen and the oxy-acetylene blowpipes for the welding of metals. There appears to be no doubt that satisfactory welds may be made with either apparatus, and the decision from the industrial viewpoint depends mainly upon the cost. The use of electrolytically produced gases is of interest so far as the oxy-hydrogen apparatus is concerned, but the advantage in point of cheapness appears to lie with the oxy-acetylene blowpipe.

ENGINEERING WORK IN CHINA.

PRESENT CONDITIONS OF CONCESSIONS FOR RAILWAY AND MINING DEVELOPMENTS IN THE CHINESE EMPIRE.

C. D. Jameson—Engineering and Mining Journal.

IT is well understood that the Chinese Empire is rich in mineral deposits, while the large population and extensive internal commerce renders it a desirable field for the development of railway enterprises. At the same time it is known that there are local difficulties connected with the improvements of these natural and commercial resources, and that outside interference, as it is considered, is not welcomed, even though it be to the advantage of the country. The present status of the subject of Chinese concessions is discussed in a paper by Mr. Charles D. Jameson, in a recent issue of the *Engineering and Mining Journal,* from which we make some abstract.

"To-day the Chinese, both Government and people, strongly oppose the granting of any further concessions for railways or mines to foreign syndicates. Not only this, but the Chinese Government is making an effort to cancel some of the existing concessions and to purchase others from the present owners. Broadly stated, the reason for this is that not one of the syndicates holding concessions in China has conformed, in either letter or spirit, to the terms of the agreement under which the concession was granted.

"Concessions in China are of most recent origin; none of them is yet ten years of age, and the majority date from 1898. Of her own free will China never granted a concession to a foreigner, and never wished to do so. The existing concessions were obtained by pressure brought to bear upon the Chinese Government by the government representing the nationality of the syndicate, and by money paid to individual officials for their good will and influence. (There are exception to this, which I refer to later). Thus China has been more or less forced into the granting of the existing concessions by the various European powers in order to balance or counterbalance the political situation in the Far East. Even this condition of affairs might have continued possible if, after the concessions had been granted, the various syndicates had carried out the terms of their agreements and had developed the concessions in a *bona fide* manner. In every instance, as soon as the original concession has been granted in accordance with a definite and written agreement as to terms, the syndicate has commenced a campaign to have the terms modified, and more modified—always to the betterment of the syndicate and the detriment of China."

An important difficulty which exists in connection with the work of a syndicate

of investors in China is the fact that the empire has not yet been admitted to the so-called family of nations upon terms of equality, so that the intercourse between China and foreign governments must be regulated by the terms of international treaties. These treaties generally contain the so-called favored nation clause, by which any advantage granted to any nation by China must also be granted to the nation included in the treaty. The result is that several nations can easily succeed in "rigging the market," so to speak. Concessions are granted to several nations, such as France, Germany and England, upon equal terms. Then one country after the other succeeds in making some slight modification of the conditions, not much in itself, but always to the benefit of the syndicate, which includes all the nations. Each nation tries this game, and all benefit, while China as a nation loses.

"The story of the Hankow-Canton railway concession to the American-China Development Company merits a rehearsal here. China feared the international complications which might arise from the granting of concessions to the larger European powers, owing to their lust for territorial aggrandizement. The Peking-Hankow line was granted to the Belgian syndicate (upon their plea that Belgium was a small power, with no territorial ambitions in the Far East). After the granting of this concession China's confidence in European powers was not increased, when it was found that the Belgian syndicate was three-quarters French; that the greater part of the money to be used was French, and that Russia had satisfied the French investors as to the perfect security of the undertaking. Therefore the southern half of China's great trunk line was not given to the Belgian syndicate, although every effort was made to bring this about. This piece of railway (Hankow to Canton) was given to the American-China Development Company. This company had done but little work to obtain this concession, and probably no money had been used. China wished America to have it in order to save herself from others. In making this contract there was a written and verbal agreement that the company and capital were to be *bona fide* American.

"In 1901 the American company had sold to the Belgians (or to those back of the Belgians) a majority of the shares which gave them the practical control of the affair; and, while the company still acted under an American charter with an American president and general manager, yet the actual management was the same as that of Peking-Hankow railway. American management in China has been most unfortunate.

"When the predominance of Belgian control became evident to China, a threat was made by the Chinese to cancel the concession. Whether this would have been possible or not is now beside the question; they succeeded, however, in making things so unpleasant for the American company that China at last received notice that all the Belgian shares had been repurchased by a Morgan group of capitalists, and that the company was *de facto* American. This occurred in 1904."

As an example of the manner in which Chinese concessions are exploited, Mr. Jameson discusses the Peking Syndicate, Limited, of London. This concession, ratified May 1, 1898, was the first *bona fide* concession for mining ever given to a foreign syndicate by the Imperial Government of China. It gave exclusive rights to work the southern half of the province of Shanis, and the portion of the province of Honan north of the Yellow river for coal and iron, this being an area of 25,000 square miles of the richest coal and iron mines in the world.

"For seven years this syndicate has held this enormous territory and not one ounce of coal or iron has it mined. The most available coal and iron deposits are in southern Shansi and northern Honan. In the district of Tse-Chow, southern Shansi, there is practically an unlimited deposit of high-grade anthracite coal lying 3,000 feet above the alluvial plain. This coal is so located that it could be mined by adits; it lies nearly horizontal, and the adits would drain themselves. The thickness of the coal in the main seam is such that ordinary coal cars could be run to the face of the workings and the coal loaded for transportation at once. The coal is in perfect condition, and contains so little dust that no cleaning would be required.

"But to reach this elevation of 3,000 feet above the plain requires a railway of 30 miles, which for a standard steam railway complete would cost £500,000. The grade would be uniform, and the road bed being mostly in rock, the cost of maintenance would be low. But this railway has not been built, and this immense visible coal supply has not been tapped. An electric railway from Tse-Chow to the plain would cost less than £200,000, and the cost of operation would be low."

The Peking Syndicate has sunk shafts at the foothills to tap a deposit which is probably 600 feet below the surface, and has built about 90 miles of railway from the shafts to Tao-Kou on the Wei river. It has also succeeded in getting the Chinese Government to guarantee its bonds for the railway at 5 per cent.

"From the standpoint of the Peking Syndicate shareholders there has been over £1,000,000 expended since the granting of the concession, and no coal or iron has as yet been mined. In the meantime, however, alien railways have been, or are being constructed on the north, south and east sides of the ceded territory; none of the coal or iron can be put on the market without paying transportation rates over railways owning, directly or indirectly, competing mines of bituminous coal. None of the bituminous coal in the Peking Syndicate area is so located as to be marketable for many years.

"While no royalties or profits have accrued to China as yet from the many valuable concessions granted by it to foreign syndicates, yet the original syndicates have reaped a rich harvest in the jugglery of the shares in the markets of London and Paris. These few examples of the methods pursued by foreign syndicates in China may explain the lack of desire and enthusiasm on the part of the Chinese to the granting of additional concessions."

THE UTILISATION OF PEAT.

METHODS OF PREPARING PEAT FOR USE AS AN INDUSTRIAL FUEL ON A COMMERCIAL SCALE.

Engineering.

THE interest which is being taken at the present time in the possibilities of peat fuel renders an editorial in a recent issue of *Engineering* timely and interesting. Especially important is the development of peat to the industries of Ireland, since the absence of coal acts to retard very materially the commercial success of manufacturing undertakings. The peat bogs of Ireland, covering areas of hundreds of miles, in beds of 20 to 30 feet in thickness, represent an enormous mass of fuel, requiring only some method of preparing it to cause it to assume commercial importance.

"In composition, peat partakes much of the nature of wood. When dried, it is found on analysis to contain about 60 per cent. of carbon, 33 per cent. of oxygen, and 6 per cent. of hydrogen. The carbon is thus present in only about two-thirds the quantity found in bituminous coal, while the oxygen is from twice to ten times the amount, the hydrogen in the two cases being about the same. Air-dried peat has, on an average, only one-half the calorific value of coal, while even when kiln-dried the proportion does not exceed two-thirds. It thus compares rather unfavorably with coal so far as heating properties are concerned, and its greater bulk and crumbliness make it less suitable for storage and transport, although these disadvantages are to some extent compensated by the fact that, being found on the surface, deep underground workings, with the heavy working costs thereby involved, are unnecessary. As a fuel it has advantages over coal in the very small amount of sulphur present, and the entire absence of slagging. Its freedom from sulphur renders the iron from peat-fed blast-furnaces equal in quality to the best charcoal iron, and the quantity of oxygen present in the substance makes a smaller air supply necessary, hence reducing the wasteful passage of nitrogen through the fuel.

"The most serious drawback to its use, however, consists in the enormous quantity of water always contained in it in its natural state. When cut from the bog, water is present to the extent of nearly

90 per cent. by weight, and even after standing in stacks in the open air until, as far as can be seen, they are perfectly dry, the sods still retain over 25 per cent. of moisture. Furthermore, in this condition, it is very bulky and friable; and though the cost of digging and stacking it is extremely low, before peat becomes a marketable commodity other treatment, with the object of drying and consolidating it, is necessary."

On the continent various plans have been tried to remove the excess of moisture from peat, these including the use of hydraulic pressure to form it into briquettes, and also the employment of centrifugal machines to throw off the water. Neither of these processes have accomplished the desired result, the method of pressure leaving more than 60 per cent. of moisture still in the peat, and the centrifugal method being also ineffective and costly. Drying by heat has been more satisfactory, but the commercial success of this process remains to be demonstrated.

"An electrical process of drying peat has been proposed, and we understand that a plant is now being erected in Ireland for the purpose of carrying out the idea on a commercial scale. After a certain amount of water has been extracted by a centrifugal machine, electrodes are inserted in the peat mass and current from a dynamo passed through for some time. The current heats the mass on account of its resistance, and is further claimed to rupture the cellular fibrous matter, and thus assist the final consolidation. It will be very surprising if such a process can compete successfully with heating by the direct action of fuel; for whereas one unit of electricity cannot possibly develop more than 3,410 heat units, and at present requires about 3 pounds of coal to produce, the direct combusion of the same coal would develop about thirteen times the amount given back on degrading the electricity into heat.

"The peat, after being dried and disintegrated, has next to be formed into small dense briquettes. The most convenient shape for these is cylindrical, having a diameter of 2 inches to 2½ inches and of equal depth. The presses used for this purpose are of two kinds: one in which the descending ram drives a certain quantity of peat into a die with a closed bottom, and the other in which the die is in the form of an open-ended tube about 12 inches long. The latter type, known as the Dickson press, from the name of its inventor, depends for its action on the friction caused by the pressure of the briquettes on the walls of the tube. It is found that a pressure of 8 tons per square inch is required to force the column of finished briquettes along the tube against the frictional resistance only, and this is sufficient to make a dense and well-finished briquette."

Far more promising than any methods of drying the peat are those which involve the conversion of the fuel into gas for direct use in internal-combusion motors. In the gas producer the presence of the moisture in the peat is not objectionable, much less steam is required for the production of the water-gas than would be required with anthracite coal or other dry fuel, while the absence of sulphur and phosphorus renders the product especially pure. In the fuel tests of the United States Geological Survey, made in connection with the St. Louis exhibition, the marked advantages of lignite as a fuel for the gas producer were strikingly demonstrated, and similar favorable conditions exist in the case of peat. Practical experiments have shown that gas produced in the ordinary way from peat has a calorific value of about 150 British thermal units per cubic foot, this corresponding closely to Dowson gas, and being well adapted for use in gas engines, while the freedom from tarry deposits give it a marked advantage. There appears to be no good reason why peat briquettes should be satisfactorily used in the suction gas producer, and this being the case there is a wide field opened for the industrial application of the fuel.

"For the utilisation of peat on a commercial scale some more efficient way of harvesting it than the usual method of digging it by hand from the bog is essential. The means adopted will depend to a great extent on the comparative dryness and solidity of the bog. In some cases much of the water can be drained away previously to attempting to remove the peat; but if that is impossible owing

to the formation of the land, a dredger, similar to those used for harbor work, is floated on the surface and delivers peat, in the form of mud, to barges in attendance. An aerial ropeway forms a convenient system of transport from the barges to *terra firma*. In the cases of fairly dry bogs the surface is cleared of growing moss, stumps of trees, etc., which will serve as fuel for the drying plant. In some of the Canadian bogs portable tramways are laid on the top of the bog to convey the peat to the works. The surface of the bog is then harrowed, and when the loosened peat has become fairly dry by the action of wind and sun, it is raked together, loaded into trucks and hauled to the briquetting works. At other bogs mechanical dredgers running of broad wheels are employed. An endless chain, fitted with alternate knives and scraping plates, works along the face of a trench about 4 feet deep. The peat sliced off is raised to the top of the machine and deposited on to a conveyor, which delivers it into a casing containing a rapidly-revolving paddle wheel. The blades of the latter drive the peat out in a continuous shower, which falls on the ground 10 or 15 yards away. The layer thus formed is about half an inch thick, and soon becomes fairly dry, when it is raked up and taken to the works."

It is thus seen that by the application of engineering methods to the utilisation of peat fuel, the great deposits existing in Ireland and elsewhere may be made available for manufacturing purposes, and it is not impossible that, in the event of a failing coal supply, other natural resources will be called upon, the peat bogs of Ireland may come to the rescue, in part, at least, of the depleted coal measures of England and Wales.

THE USE OF ELECTRICAL INSTRUMENTS.

PRACTICAL CONSIDERATIONS IN CONNECTION WITH THE HANDLING OF ELECTRICAL INSTRUMENTS IN RELATION TO THEIR ACCURACY.

H. B. Taylor—Electric Journal.

WITH the advent of electricity into the domain of practical engineering the working engineer has been put into charge of a variety of instruments of a totally different nature from those to which he was formerly accustomed. The steam engineer has his pressure gauges and water glasses, and of late he has become fairly well accustomed to the use of the indicator. When a test is to be made there will also be used a calorimeter, to determine the proportion of moisture, while water meters, thermometers, and in some cases barometers are brought into the engine and boiler room, but usually in company of an expert who uses them himself and carries them away with him.

The instruments in daily use in the electrical generating station are of a totally different kind, but at the same time all measuring appliances have fundamental principles in common, and it is very desirable that the men by whom such appliances are used should have some general ideas of their construction and the right use of them to obtain reliable results. In a paper by Mr. H. B. Taylor, in a recent issue of the *Electric Journal*, there are a number of excellent suggestions upon this subject, and an abstract of the principal points will be found of interest.

"In using electrical measuring instruments and in setting them up for making a test, there are certain points to be considered which are likely to be overlooked by men who have not frequent occasion to use them. This is especially true where a number of instruments are to be used on one test. In the effort to put all the instruments in places where they can be conveniently read and at the same time have other apparatus within easy reach, there are many chances of placing some of the instruments in locations where their calibration will be temporarily affected by their influence upon each other or by the effect of some other piece of apparatus or part of the conducting circuit.

"A knowledge of the principle upon which an instrument operates, the location of its winding and of its magnet, if

any, should enable the person using it to judge whether a particular location is suitable. Some instruments are quite susceptible to external influences, while with others, scarcely any attention need be paid to the location of stray magnetic fields. So many kinds of instruments are in use that it would not be possible in a short article to discuss the different types, or the various capacities of those of any particular type, but it may be said in general that there are more opportunities for error in measuring heavy currents than in measuring small ones. In direct current work there may be disturbing influences entirely apart from the apparatus in use on the test; such, for instance, as the field of a motor or a generator or a nearby bus-bar carrying heavy currents. Instruments containing permanent magnets will, if placed too close together, influence each other. The natural tendency is to place them in almost the worst possible position; that is, side by side. A space of from two to three feet may be taken as a safe distance to allow between direct current meters of the ordinary portable type. When space is very limited, two instruments can often be brought closer together without causing trouble, by placing one of them with its scale inverted with respect to the other, so that the neutral parts of the magnets are nearest to each other and the pole pieces as far apart as possible. For the most accurate results even the earth's magnetic field must be taken into account, the maximum possible variation in reading from this cause being usually a little more than one-tenth of one per cent."

It is a well known principle in using many kinds of instruments to employ the principle of reversal, just as a draftsman tests the correctness of a triangle by drawing a perpendicular and then turning the triangle over to see if the two lines coincide. In like manner Mr. Taylor advises that electro-magnetic instruments designed for use on both alternating and continuous currents should be read with the current first in one direction and then in the other when employed with direct currents. If the readings do not agree, their mean will be the correct reading.

In the case of alternating and direct current instruments designed for heavy currents, especial care must be taken in bringing in the lead. Such instruments usually have only a turn or two in the coils carrying the main currents, and if the wires bringing the current to them form a loop a disturbing magnetic field will be created.

Mr. Taylor discusses the various methods of determining the corrections for instrumental errors, and although such corrections should be furnished by the maker of the instrument it is desirable to be able to verify the factors or to find them if they have not been given.

"Modern electrical instruments will stand a great deal of service under severe conditions if proper care and judgment are exercised in handling them. They will even stand a certain amount of ill treatment that would seldom be met with except through carelessness. Experience shows, nevertheless, that there are few instruments in daily service which do not occasionally meet with more or less damage. In nearly all instances where a meter is overheated, broken, or otherwise thrown out of adjustment, the cause of trouble is quite apparent as soon as the damage is done, and the person responsible finds that he knew beforehand what would happen under the conditions which caused the trouble, but had failed to notice that these conditions existed. When a man connects an ammeter in shunt across a 500-volt circuit it is seldom because he thought that the proper way, but because he thought he had a resistance, or something having the same effect, in series. To have mentioned to him a week previously that ammeters should not be connected that way would probably not have prevented the accident. It is therefore not easy to compile a useful list of connections to be avoided."

No satisfactory method appears to have been devised for protecting voltmeters against sudden overloading, and the best plan for avoiding injury is to keep them disconnected at all times when readings are not being taken. Fuses will prevent the windings from being actually burned out, but they cannot prevent the mechanical injuries due to sudden overload shocks.

"The question of zero errors and how to correct for them is of frequent occurrence. Sooner or later the index of nearly every

meter fails to indicate zero at zero load. The exact reason is not always apparent. It may be known that the error appeared immediately after a short circuit or after the meter was dropped to the floor, but that information would not show whether the spring had changed its shape, the index bent, some part of the movement slipped or one or more of a number of other possible disarrangements had happened. A rather common source of error at zero as well as at other readings is a fine springy piece of lint resting on a fixed part and pressing lightly against the movable part in such a way as not to cause friction, but acting as a little additional spring.

"To add, algebraically, the zero error to the observed reading seldom gives exactly correct results. Sometimes it introduces a greater error than if no correction had been attempted."

Scale corrections are necessary in nearly all kinds of graduated instruments if the highest degree of accuracy is required, and in general no uniform law is found to govern the variations in different parts of the scale. In ordinary daily service such a high degree of precision is generally not required, but when the best results are demanded, as in careful scientific testing, the errors of all parts of the scale should be tabulated, as is the case with first-class thermometers or barometers, and the necessary correction can then be applied before any computations have been made.

ENGINEERING AND IRRIGATION.

THE WORK OF THE ENGINEER IN THE REGULATION AND CONTROL OF WATER SUPPLY FOR IRRIGATION PURPOSES.

British Association for the Advancement of Science.

THE visit of the British Association for the Advancement of Science to South Africa is a matter of general interest, while among the various papers there are several appealing to the engineer because of their special applicability to different departments of applied science. Among these we note the presidential address to the engineering section, by Colonel Sir C. Scott Moncrieff, dealing especially wth irrigation problems and their solutions in various parts of the world.

After briefly referring to primitive methods of distributing water over arid portions of land, Col. Moncrieff proceeds to discuss the subject from the viewpoint of the modern engineer.

"Irrigation on a large scale is best effected by diverting water from a river or lake into an artificial channel, and thence on to the fields. If the water surface of a river has a slope of 2 feet per mile, and a canal be drawn from it with a surface slope of 1 foot per mile, it is evident that at the end of a mile the water in the canal will be 1 foot higher than that in the river; and if the water in the river is 10 feet below the plain, at the end of 10 miles the water in the canal will be flush with the plain, and henceforth irrigation can be effected by simple gravitation. When there is no question of fertilizing deposit, and only pure water is to be had, the most favorable condition of irrigation is where the canal or the river has its source of supply in a great lake. For, be the rainfall ever so heavy, the water surface in the lake will not rise very much, nor will it greatly sink at the end of a long drought. Where there is no moderating lake, a river fed from a glacier has a precious source of supply. The hotter the weather, the more rapidly will the ice melt, and this is just when irrigation is most wanted. Elsewhere, if crops are to be raised and the rain cannot be counted on nor well irrigation be practised, water storage becomes necessary, and it is with the help of water storage that in most countries irrigation is carried on.

"To one who has not given the subject attention surprise is often expressed at the large volume of water that has to be stored to water an acre of land. In the case of rice irrigation in India it is found that the storage of a million cubic feet does not suffice for more than from six to eight acres. For the irrigation of wheat about one-third this quantity is enough. It would never pay to excavate on a level plain

a hollow large enough to hold a million cubic feet of water. It is invariably done by throwing a dam across the bed of a river or a valley and ponding up the water behind it. Many points have here to be considered—the length of dam necessary, its height, the material of which it is to be constructed, the area and the value of the land that must be submerged, the area of the land that may be watered. The limits of the height of a dam are from about 150 feet to 15 feet. If the slope of the valley is great, it may be that the volume which can be ponded up with a dam of even 150 feet is inconsiderable, and the cost may be prohibitory. On the other hand, if the country is very flat, it may be that a dam of only 20 feet high may require to be of quite an inordinate length, and compensation for the area of land to be submerged may become a very large item in the estimate. I have known of districts so flat that in order to irrigate an acre more than an acre must be drowned. This looks ridiculous, but is not really so, for the yield of an irrigated acre may be eight or ten times that of an unirrigated one; and after the storage reservoir has been emptied it is often possible to raise a good crop on a saturated bed.

"The advantage of a deep reservoir is, however, very great, for the evaporation is in proportion to the area of the surface, and if two reservoirs contain the same volume of water, and the depth of one is double that of the other, the loss by evaporation from the shallow one will be double that of the deep one. In India, from time immemorial, it has been the practice to store water for irrigation, and there are many thousands of reservoirs, from the great artificial lakes holding as much as 5,000 or 6,000 millions of cubic feet, down to the humble village tank holding not a million. There are few of which the dam exceeds 80 feet in height, and such are nearly always built of masonry or concrete. For these it is absolutely necessary to have sound rock foundations. If the dam is to be of earth the quality of the soil must be carefully seen to, and there should be a central core of puddle resting on rock and rising to the maximum height of water surface. If the dam is of masonry there may perhaps be no harm done should the water spill over the top. If it is of earth, this must never happen, and a waste weir must be provided, if possible cut out of rock or built of the best masonry, and large enough to discharge the greatest possible flood. More accidents occur to reservoirs through the want of sufficient waste weirs or their faulty construction than from any other cause.

"As important as the waste weir are the outlet sluices through which the water is conveyed for the irrigation of the fields. If possible they should be arranged to serve at the same time as scouring sluices to carry off the deposit that accumulates at the bottom of the reservoir. For, unless provided with very powerful scouring sluices, sooner or later the bed of the reservoir will become silted up, and the space available for water storage will keep diminishing. As this happens in India, it is usual to go on raising the embankment—for it does not pay to dig out the deposit, and so the life of a reservoir may be prolonged for many years. Ultimately it is abandoned, as it is cheaper to make a new reservoir than to dig out the old one."

Col. Moncrieff refers briefly to the irrigation systems of Italy, India, Egypt and America, all of these countries showing the large return in value derived from the introduction of irrigation works upon regions otherwise of small value. Thus the total cost of the Assouan dam, the Assiout barrage, and the canal work connected with the improvements which have been made in Egypt, is given as about £6,500,000, while the rental value of the land has been increased by £2,637,000 and the sale value by £26,570,000.

"It is evident that there are many serious considerations to be taken into account before entering on any large project for irrigation. Statistics must be carefully collected of rainfall, of the source of water supply available, and of the amount of that rainfall which it is possible to store and utilize. The water should be analyzed if there is any danger of its being brackish. Its temperature should be ascertained. It should be considered what will be the effect of pouring water on the soil, for it is not always an unmixed benefit. A dry climate may be changed into a moist, and

fever and ague may follow. In India there are large tracts of heavy black soil, which with the ordinary rainfall produce excellent crops nine years out of ten, and where irrigation would rather do harm than good. But in the tenth year the rains fail, and without artificial irrigation the soil will yield nothing. So terrible may be the misery caused by that tenth year ot drought that even then it might pay a government to enter on a scheme of irrigation. But it is evident that it might not pay a joint stock company. In all cases it is of the first importance to establish by law the principle that all rivers or streams above a certain size are national property, to be utilized for the good of the nation. Even where there is no immediate intention of constructing irrigation works, it is well to establish this principle. Otherwise, vested rights may be allowed to spring up, which it may be necessary in after years to buy out at a heavy cost."

The large extent of modern irrigation works and the complex industrial conditions by which they are surrounded raises them above the level of ordinary commercial undertakings and places them on a plane which demands that they shall be placed under government control. In Italy important works were originally undertaken by private enterprise, but these were subsequently taken over by the government, upon the failure of the original syndicate to conduct them successfully. In the United States there are great reclamation undertakings now being executed by the national government, and in general it seems to be conceded that such plans are too closely connected with the general welfare of a country to be governed by strict commercial considerations, but fall rather into the category of the control of navigation, or the transmission of intelligence.

STORES KEEPING IN RAILWAY WORK.

PRACTICAL METHODS OF ORGANIZING AND OPERATING THE STORES-KEEPING DEPARTMENT OF A RAILWAY SYSTEM.

C. F. Balch—Railway Age.

IN the complete organization of a works management system the stores department necessarily occupies an important position, and there have already been published among the leading articles in this magazine papers discussing the subject as developed in various manufacturing establishments. In a recent issue of the *Railway Age* we note a paper by Mr. C. F. Balch, giving the results of practical experience under the peculiar conditions involved in railroad service, and some of the points brought out will be found of interest, both to railroad men and other managers of industrial establishments.

"The importance of the store department is very often underrated and its claims made secondary to those of the other operating departments, but it is a fact that the store department of a railroad is as necessary to its successful operation as the commissary department of an army is to a successful military campaign, and the development of the store department to the highest degree of efficiency, as a means of economizing the use of material, should be the earnest desire of every operating official.

"The requirements of railway service are more and more exacting, as the systematic movement of traffic made necessary by severe competition demands each year an increasing degree of excellence in all departments, in order that nothing shall prevent the correct working of every branch of the service which makes a successful general result possible. This touches the store department in the measure that it requires a degree of promptness in delivering material where needed, which makes it necessary to anticipate every requirement and thus avoid the possibility of the service being in any measure impaired or injured by the lack of material; especially is this true with regard to repairs of rolling stock, for during busy periods, when it is absolutely necessary to utilize every possible resource, any delay for lack of material will cost possibly several times the value of the material required, in the loss of traffic, and produce a result which cannot be definitely known but which is to be deplored, and the more so as it is possible to avoid it. This par-

ticular feature of the store department is very important, and has been of that conspicuousness that it has been largely the cause of the store department being in many cases made subordinate to the mechanical department, either from choice, or from the fact that from the lack of desire on the part of any other department to assume the responsibility of these very contingencies, when it was possible to avoid so doing, the responsibility naturally gravitates to the mechanical department, and so the store department has found its lodging in the arms of the mechanical department. It follows that the organizing of a store department as a separate department is a decided relief to the mechanical department, and very much to its advantage."

Mr. Balch divides the stores department problem into the distinct lines of facilities, organization, and operation. Broadly the arrangement of stores keeping facilities may well be based upon the department store idea, the contents being arranged in groups so that each department may receive its proportional degree of attention.

So far as the organization is concerned, Mr. Balch emphasizes the importance of making adequate provision for a sufficient physical force to handle the material promptly, and an ample clerical force to check and record the movement of the stock and to have it fully and properly accounted for.

"The correct operation of the store department should result in the prompt, precise procuring of material from the manufacturers, and delivery at the point on the line where required for service. A few suggestions only in this line are herein stated.

"There should be a generally simple and concise method of diffusing information through the department, examples of which are as follows:

"A well compiled list of castings is essential, giving pattern number and information concerning each pattern, in handy form well bound, and in such shape that every car repairer, shop foreman or other official ordering material from the store department may give the correct description of articles desired.

"The value of material should be emphasized to everyone using it. For example, have the prices printed opposite the name of each item on the form on which each section foreman makes his monthly report of tools and material on hand, thus bringing before him the exact meaning in a money way of the materials in his charge.

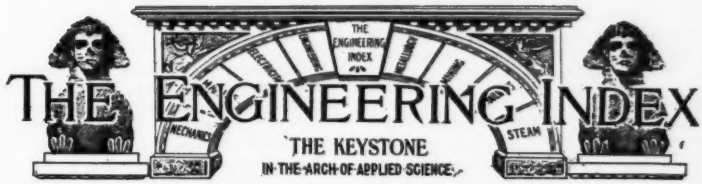
"A careful estimate of materials on hand each month must be made, and record of the same in such a way as to form statistics from which future needs may be anticipated. Examples of this are in stock books, the stock card, card systems of requisitions, stock sheets, etc., which systems have varying values under different conditions, and are more or less practical as they are carefully manipulated or otherwise.

"At large points, where it is necessary for papers to pass through many hands for approval and then several hands at the storehouse before the final action of loading occurs, it is necessary that all papers be quickly understood, and that descriptions be explicit to avoid both errors in the conception of the order by approving officials, as well as errors in the shipment of the material.

"Prompt movement of all papers connected with the disbursements of materials is most important. If a request for a bill of material lies on the desk of an approving official for one week it is as detrimental to the prompt delivery of that material as though the material was loaded in a car and stood on a sidetrack for an equal length of time. The latter would quite likely be severely criticized by that same official, who would hold the papers a week for signature.

"The use or application of material to the service is quite another subject, and its particular bearing in this connection is that where the store department is lacking in efficiency, it has a tendency to thwart the efforts of the management in instituting economical practices.

"The object of it all is to have what you want, where you want it, when you need it, and any failure to accomplish this causes the substitution of something else, either not so suitable, or more expensive, or in other ways not so well adapted to the service as the correct material."



The following pages form a **descriptive** index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Arches.

The New Masonry Arch Bridge at Plauen, Saxony, and two bridges in the Black Forest. W. J. Douglas. Illustrates and describes three interesting masonry arches. 2500 w. Eng News—Aug. 17, 1905. No. 71378.

Accident.

The accident to the Maximilian Bridge at Munich (L'Accident du Pont Maximilien à Munich). Describing the slipping and displacement of one of the hinges of an arch, with computation of the magnitude and direction of the forces causing this action. 1800 w. Génie Civil—July 22, 1905. No. 71516 D.

Cantilever.

Cantilever Bridge Across the River Mattig, Austria. Gives skeleton elevation and plan of a three-span cantilever bridge recently erected, with description from

We supply copies of these articles. See page 159.

Le Génie Civil. 600 w. Eng, Lond—July 28, 1905. No. 71259 A.

Cantilever Bridge over the Mississippi River. Begins an illustrated detailed description of the Thebes Bridge. 1600 w. Eng, Lond—July 21, 1905. Serial. 1st part. No. 71169 A.

Floors.

Protecting and Water—Proofing Solid Floor Bridges. W. C. Cushing. Reprinted from Bul. 64 of the Am. and Main. of Way Assn. An illustrated explanation of some of the plans used on the P., C., C. & St. L. at Brighton Park and Engelwood, in 1904. 5500 w. R R Gaz—Vol. XXXIX., No. 5. No. 71224.

Foundations.

Compressed Air Foundations for Bridges. G. W. M. Boycott. An illustrated article dealing with pneumatic cylinders and caissons only, and giving brief descriptions of work in England. 2800 w. Eng, Lond—Aug. 4, 1905. Serial. 1st part. No. 71367 A.

Loads.

Maximum Bending Moments Due to Rolling Loads. An investigation of the stresses produced by loads rolling over bridges. Explains method of obtaining the greatest stress for two, three and four loads, and general conclusions for all loads. 2000 w. Eng, Lond—July 21, 1905. No. 71168 A.

Manhattan.

The Superstructure of the Manhattan Bridge, New York. An illustrated general description of the third East River Suspension Bridge. 2800 w. Eng Rec—July 29, 1905. No. 71125.

Plate-Girder.

The erection of the Great Tonoloway Creek Bridge. Illustrates and describes the erection of a deck bridge having three single-track plate-girder skew spans, on a sub-structure built to receive two additional lines of girders when the road is double-tracked. 1600 w. Eng Rec—July 29, 1905. No. 71131.

Rail-Bearers.

The Deflection of Continuous Rail-Bearers. Max am Ende. Begins a mathematical discussion of rail-bearers having a uniform support. Continuous rail-bearers are used in railway bridges for the distribution of pressure from a rolling load upon several cross-girders. 1700 w. Engng—July 21, 1905. Serial. 1st part. No. 71160 A.

Reconstruction.

Replacing a Four-Track Bridge Under Heavy Traffic. Brief account of methods adopted in replacing an old structure by a new one without interrupting traffic. The bridge carries the N. Y. C. & H. R. R. R. over the Erie canal near Newark, N. Y. Ills. 1000 w. Eng Rec—July 29, 1905. No. 71128.

Reinforced Concrete.

Reinforced Concrete Bridges in a Newark Park. Illustrated description of two single-arch bridges of monumental design, in Branch Brook Park, with the methods of construction. 2500 w. Eng Rec—Aug. 12, 1905. No. 71330.

The Kazarguene Bridge. Illustrates and describes a bridge 985 feet long, built of reinforced concrete. The methods of construction, and the materials are discussed. 1700 w. Sci Am Sup—Aug. 12, 1905. No. 71283.

Suspension.

The Chain Suspension Bridge at Budapest, Hungary. An illustrated account of a large bridge of unusual construction, describing the methods of erection and features of interest. 4500 w. Eng News—Aug. 24, 1905. No. 71477.

Wire Cables and Wide Cable Spans (Drahtseile und Grosse Seilspannweiten). Sigfried Abt. Describing improved methods of laying wire cables, together with data about wide suspension spans. 2000 w. Schweiz Bauzeitung—July 15, 1905. No. 71588 B.

Treskow.

The Treskow Bridge at Oberschöneweide near Berlin (Die Treskow-Brücke zu Oberschöneweide bei Berlin). Karl Bernhard. A very full account of the new bridge over the Spree, with full details of construction. The main span is 226 feet. Three articles. 9000 w. Zeitschr d Ver Deutscher Ing—July 15, 29, Aug. 5. No. 71503 each D.

Viaducts.

The Erection of the Bellevue Viaduct. Illustrated description of a viaduct, near Pittsburg, which will carry a double-track electric railway, highway traffic, and six sidewalks. 1000 w. Eng Rec—Aug. 26, 1905. No. 71620.

The Erection of the James River Viaduct, Richmond, Va. Illustrated description of the design and construction. 1200 w. Eng Rec—Aug. 5, 1905. No. 71241.

Washington, D. C.

The Anacostia Bridge, Washington, D. C. An illustrated description of an unusually interesting structure, 1000 feet long, consisting of six arches and one drawspan. 1500 w. Ry Age—Aug. 11, 1905. No. 71301.

The Anacostia Bridge, Washington. Begins an illustrated detailed description of the steel arch deck structure across the Potomac River, under construction

We supply copies of these articles. See page 159.

by the U. S. government. 2500 w. Eng Rec—Aug. 19, 1905. Serial. 1st part. No. 71440.

CONSTRUCTION.

Beams.

The Theory of Laterally Curved Beams (Zur Theorie der Seitlich Gekrümmten Träger). A mathematical study of the forces acting upon curved beams such as are employed in balconies and similar structures. 2500 w. Deutsche Bauzeitung—July 26, 1905. No. 71590 B.

Blast.

Destruction of Henderson's Point. Charles B. Morse. An illustrated description of the methods used in removing this rocky point at Kittery, Maine, made necessary in the widening of the channel of the Piscataqua River, so that large warships might reach the new drydock. 1400 w. Compressed Air—Aug. 1905. No. 71471.

The Great Blast at Henderson's Point, Portsmouth Navy Yard. Illustrates and describes the explosion of 38 tons of dynamite, in a submarine blast. The method used was of unusual interest. 1400 w. Eng News—Aug. 3, 1905. No. 71175.

Buckling.

A Simple Demonstration of the Principles of Buckling Action (Eine Einfache Vorrichtung zur Veranschaulichung des Knickungsvorganges). A. Summerfeld. Describing an experimental method by observing the vibrations of a rod fastened at one end and adjustable as to length. 2500 w. Zeitschr d Ver Deutscher Ing—Aug. 12, 1905. No. 71512 D.

Building Construction.

The Erection of the Wanamaker Building, Philadelphia. Illustration, with brief description of methods of construction. 1800 w. Eng Rec—Aug. 5, 1905. No. 71243.

Contractor's Plant.

Electric Installation for Contractor's Plant on Brooklyn Anchorage of Manhattan Bridge. Describes the electric plant for the use of power instead of hand labor whenever possible. Electric apparatus is used for pile-driving, hoisting, traction, concrete mixing, pumping and lighting. 1500 w. Ills. Eng Rec—Aug. 26, 1905. No. 71622.

Dams.

Investigation of Stresses in High Masonry Dams of Short Spans. George Y. Wisner and Edgar T. Wheeler. A report made to F. H. Newall, Chief Engineer of the U. S. Reclamation Service. Gives a general discussion by Mr. Wisner and Mr. Wheeler's analysis of stresses in the proposed Pathfinder Dam, Wyoming. 4000 w. Eng News—Aug. 10, 1905. No. 71276.

On the Stability of Masonry Dams. Karl Pearson. A reply to Mr. Dilley's criticisms of an earlier article on this subject. 2200 w. Engng—Aug. 11, 1905. No. 71460 A.

Stresses in Dams. J. S. Wilson and W. Gore. Gives an experimental method of investigating the distribution of stress in dams, cet. Ills. 1800 w. Engng—Aug. 4, 1905. No. 71359 A.

Dam.

The Wachusett Dam of the Metropolitan Water Works. George W. Blodgett. Illustrates and describes some of the principal features of the design of this great masonry dam, and the methods of construction. Also editorial. 4000 w. R R Gaz—Vol. XXXIX. No. 5. No. 71223.

Docks.

New Dock at Manchester. An illustrated article describing the interesting features. 1200 w. Engr, Lond—July 28, 1905. No. 71258 A.

Filling.

The Handling of Material for Filling Grant Park, Chicago. Illustrated description of the interesting dumping equipment used for this work. 1200 w. Eng News—Aug. 24, 1905. No. 71479.

Foundations.

Chicago Foundations. E. C. Shankland, in the *Technograph*. Explains the character of the soil and the troubles causing the great settlement of buildings, describing the kind of foundation now used. 2700 w. Eng Rec—July 29, 1905. No. 71130.

See Civil Engineering, Bridges.

Lighthouse.

Building the Beachy Head Lighthouse. Notes from a paper by Albert H. Case, submitted to the Inst. of Civ. Engrs., describing and illustrating the methods used in erecting this new lighthouse. 3700 w. Eng Rec—July 29, 1905. No. 71126.

Retaining Walls.

Concerning Retaining Walls and Earth Pressures. H. P. Boardman. Discusses the principal retaining wall theories and their defects, and considers their strength and stability, and suggests the making of experimental tests on a large scale to obtain data concerning the lateral pressure of earth. 5500 w. Eng News—Aug. 17, 1905. No. 71380.

Roofs.

Machine Shop Roofs. John E. Sweet. A short article, with sketches, giving

suggestions for the design of roofs. 600 w. Cassier's Mag—Aug., 1905. No. 71386 B.

Steel Framework.

Steel Work of the New General Electric Machine Shop. Begins an illustrated detailed description of this building at Schenectady which represents the best construction and latest features for buildings of its class. 1300 w. Eng Rec—Aug. 12, 1905. Serial. 1st part. No. 71322.

Tunnels.

Construction of the Pocahontas Tunnel, New York Central R. R. Illustrates and describes improvements on the Harlem Division of this road, near New York City, giving details of construction work. 1700 w. Eng Rec—Aug. 26, 1905. No. 71623.

Reinforced Concrete Passenger Tunnel —C. R. R. of N. J. Illustrations showing the plans of a subway which this railroad is now building under its main line at Netherwood, N. J. Description. 600 w. R R Gaz—Vol. XXXIX. No. 6. No. 71311.

The Barrientos Tunnel, Mexico. C. Gordon Paterson. Brief illustrated description of this tunnel and the methods of construction. 900 w. Eng News—Aug. 10, 1905. No. 71275.

The New Jersey Tunnels and Subways. Map, with explanation and description, showing the connections of Manhattan Island and the mainland by tunnels, including also the East River tunnels. 1600 w. Sci Am—Aug. 12, 1905. No. 71281.

The Telephone Tunnels in Chicago. Information of interest taken from the report of the Commissioners appointed to study these tunnels, giving the history of the undertaking, and the effect on the streets and buildings. 2000 w. Eng Rec —Aug. 26, 1905. No. 71621.

Tubular Tunnels in Water Bearing Soil (Les Tunnels Tubulaires en Terrains Aquifères). C. Birault. An account of the tunnels under the Seine for the new lines of the Paris Metropolitain. 15000 w. 2 plates. Mem. Soc. Ing. Civ. de France —June, 1905. No. 71596 G.

Tunnel Construction and the Subsidence of Streets in Chicago. Gives particulars from the report of a commission of engineers appointed to investigate the matter, showing the construction work and the relation to street settlements, attributing the trouble to excavation without the use of air pressure. 3500 w. Eng News—Aug. 24, 1905. No. 71481.

Ventilating Plants for the Construction of Large Alpine Tunnels (Die Luftungsanlagen beim Baue der Grossen Alpentunnels). Karl Brabbée. A review of experience in the ventilation of tunnels during construction; with special reference to the Bosruck, Tauern, Karawanka, and Wochein tunnels. Serial. Part I. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—Aug. 11, 1905. No. 71538 D.

MATERIALS OF CONSTRUCTION.

Cement.

The Proportions of Cement Mixtures. S. B. Newberry. Explains the chemical calculations used in controlling Portland cement raw mixtures. 3000 w. Cement Age—July, 1905. No. 71318.

The Works of the Kansas Portland Cement Co. Ellis Soper. Illustrated description of the plant and its operation. 2000 w. Eng Rec—Aug. 12, 1905. No. 71329.

Cement Kilns.

The Heat Balance of the Rotary Cement Kiln (Die Wärmebilanz des Zement-Drehofens). Carl Naske. An examination of the performance of various American cement kilns, deducing a heat balance. The conclusions of Richards are criticised. 3500 w. Zeitschr d Ver Deutscher Ing—Aug. 19, 1905. No. 71587 D.

Concrete.

An interpretation of Recent Tests on the Fire Resistance of Concrete. Examines the tests made by Prof. Ira H. Woolson, and tests made by the committee of the National Fire Protection Association. 2500 w. Eng News—Aug. 24, 1905. No. 71480.

Another Use for Cement Concrete. Illustrates and describes a method of making a cheap and efficient system of ducts for underground cables. 900 w. Cement Age—Aug., 1905. No. 71497.

Curing Concrete Blocks. H. H. Rice. Discusses some points of importance in securing strength in these blocks, with remarks on their value as a building material. 1000 w. Ing Rec—July 29, 1905. No. 71129.

Tests to determine the Fire Resistance and Heat Conductivity of Concrete. Abstract of a special committee report presented at the meeting of the Nat. Fire Protection Association. Describes tests based on the theory that the fire resistance depends on the ability to withstand cracking and its heat insulating value. 2000 w. Eng News—Aug. 3, 1905. No. 71177.

Reinforced Concrete.

Concrete and Concreté-Steel in Holland. J. J. L. Bourdrer. Reviews the progress made in the use of this material in Holland, considering new uses to

which it has been applied, important works completed and under construction. Ills. 5000 w. Cement Age—July 1, 1905. No. 71319.

Reinforced Concrete. Begins an illustrated description of the most important and fundamental systems. 1500 w. Sci Am Sup—Aug. 26, 1905. Serial. 1st part. No. 71487.

See also Civil Engineering, Bridges.

Sewer Pipe.

Causes of Body Crazing in Sewer Pipe. Walter A. Hull. Abstract of a paper read before the Am. Ceramic Assn. Describes the clay used in the factory where the observations were made, and the trouble with body-crazing, giving a study of the causes and the preventive measures. 3800 w. Eng Rec—Aug. 19, 1905. No. 71443.

MEASUREMENT.

Topography.

Outline of Work of the Topographic Branch of the United States Geological Survey, with details of secondary (Plane Table) Triangulation. Joseph A. Close. Ills. Explains methods used in making a surface map of the country. 12600 w. Sch of Mines Qr—July, 1905. No. 71296 D.

MUNICIPAL.

Dust Prevention.

The Oiling of Highways (Ueber Oelbesprengung von Strassen). F. Drobny. Describing the experiments made with oil sprinkling to prevent the raising of dust in the streets of Carlsbad. 3000 w. Zeitschr d Oesterr Ing u Arch Ver—Aug. 4, 1905. No. 71537 D.

London Traffic.

Report of the Royal Commission on London Traffic. Extracts from the report of commissioners appointed to inquire into the means of locomotion and transport in London. Also editorial. 15200 w. Elect'n, Lond—July 21, 1905. No. 71158 A.

Municipal Work.

Recent Municipal Work in Philadelphia. From the report of George S. Webster. Briefly considers improved sanitation, parks and parkways, laboratory work, etc. Ills. 2200 w. Eng Rec—Aug. 19, 1905. No. 71444.

Pavements.

Some Unusual Experience With Asphalt Pavements. Describes the pavement of Clinton street, Brooklyn, where three distinct pavement were laid in successive layers. A new asphalt pavement is now being laid. 1000 w. Eng Rec—Aug. 5, 1905. No. 71240.

Sewage.

An Often Neglected Factor in Sewage Analysis. Ellen H. Richards. On the importance of time where life is concerned in the change. Gives reports of tests made. 700 w. Tech Qr—June, 1905. No. 71145 E.

A Winter Visit to Some Sewage Disposal Plants in Ohio, Wisconsin, and Illinois. C. E. A. Winslow. Report on what was seen at about a dozen plants under the most unfavorable conditions of operation. Discloses inefficiency in the winter operation of many of the plants. General discussions. Ills. 11000 w. Jour Ass'n of Engng Socs—June, 1905. No. 71407 C.

Concerning Sewage Disposal from the Standpoint of Pollution of Oysters and Other Shellfish, and Especially with Reference to Their Transmission of Typhoid Fever. George W. Fuller. A concise summary of the most prominent instances of epidemics of typhoid fever and other diseases due to polluted oysters and other shellfish. Suggestions for correcting this danger. Discussions. 16000 w. Jour Fr Inst—Aug., 1905. No. 71293 D.

On the Sterilization of Effluents. Samuel Rideal. A discussion of this subject with special reference to oysters and other shellfish, and to watercress beds. Also discussion. 17600 w. Jour Roy San Inst—Aug., 1905. No. 71313 D.

Sewage Purification with Special Reference to the Problem in Ohio. R. Winthrop Pratt. Gives a brief account of the general history and theory of sewage purification, and states the geological conditions in Ohio which affect this problem, describing some of the principal Ohio plants. Ills. 10500 w. Jour Ass'n of Engng Socs—June, 1905. No. 71406 C.

The Treatment of Crude Sewage in Triple Contact-Beds. T. Hughes. From a paper before the British Ass'n of Mgrs. of Sewage Disposal Works. Gives the results of six years endeavor to deal with crude sewage in "bacteria" or "contact-beds" without any preliminary treatment or separation. 5400 w. Mining Engng—Aug., 1905. No. 71287 C.

Sewers.

Difficulties of Construction in an Outlet Sewer. From a report by Alexander Potter; concerning the unusual difficulties encountered in the construction of the joint outlet sewer of Essex and Union counties, New Jersey. 4000 w. Eng Rec—Aug. 19,1905. No. 71439.

Some Specialties of the System for Flushing the New Sewers of the City of Mexico. Roberto Gayol. Detailed description of sewers and sewerage system, with many illustrations and plans. 4000 w. Pro Am Soc of Civ Engrs—Aug., 1905. No. 71645 E.

We supply copies of these articles. See page 150.

The Walworth Sewer, Cleveland, Ohio. Walter Camp Parmley. Complete description, very fully illustrated, of the largest sewer in Cleveland. 20000 w. Pro Am Soc of Civ Engrs—Aug., 1905. No. 71646 E.

The Use of Concrete in Sewer Construction. W. C. Parmley. States the advantages of concrete sewers over brick masonry, and gives notes and observations of personal experience in the construction of concrete sewers. Illustrations and general discussion. 12000 w. Jour Ass'n of Engng Socs—June, 1905. No. 71405 C.

Smoke Prevention.

The Smoke Nuisance and its Abatement (Die Rauchplage und Ihre Bekämpfung). Eduard Meter. A general discussion of the smoke problem in Vienna. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—July 21, 1905. No. 71536 D.

WATER SUPPLY.

Cincinnati, O.

Progress of Work on the New Water Supply System of Cincinnati, O. Reviews the present conditions of the different parts of the system. Ills. 2500 w. Eng News—Aug. 24, 1905. No. 71478.

Filtration.

Mechanical Filters of the Brooklyn, N. Y., Water Works. Illustrates and describes two mechanical filter plants, built to purify a small portion of the water supply, which have given uniformly good results since completed, about two years ago. 3000 w. Eng Rec—Aug. 26, 1905. No. 71619.

The Employment of Restraining Culture media in testing the hygienic Efficiency of Sand Water Filters. A. Robin. Remarks on the defects of methods employed for testing filters, giving tabulated results, and discusses the employment of restraining media for determining the hygienic efficiency, especially bile and salt agar, and the results. 4500 w. Eng News—Aug. 17, 1905. No. 71379.

Ground Water.

The Movement of Ground Water (Over de Beweging van Grondwater). J. M. K. Pennink. Describing interesting experiments with artificial sand beds, reproducing natural conditions of subterranean water flow. 3500 w. De Ingenieur —July 29, 1905. No. 71589 D.

Lick Observatory.

An Example of the Legitimate Use of Water for Domestic Purposes. K. F. Cooper. Facts and figures showing the economical and yet ample use of water at the settlement at Lick Observatory, California. 1000 w. Pro Am Soc of Civ Engrs—Aug., 1905. No. 71647 E.

Pipe Corrosion.

Electrolysis on the Metropolitan Water Works. Extracts from the report of F. P. Stearns for the last year, giving results of tests made and conditions found when the annual survey was made to determine the corrosion due to the electrolytic action of stray currents. 1600 w. Eng Rec —July 29, 1905. No. 71127.

Pressure.

Pressure in City Water Works from Fire Protection View-point. Abstract of the report of E. G. Hopson. Urges the extended use of sprinkler equipments, effective interior standpipe services, and discusses the value of higher pressures for fire protection and the objections. 4000 w. Eng Rec—Aug. 19, 1905. No. 71442.

Pumping Engine.

See Mechanical Engineering, Hydraulics.

Rates.

The Principles Governing the Valuation for Rate Fixing Purposes of Water Works Under Private Ownership. Arthur L. Adams. Read before the Pacific Coast Engng. Cong. Considers the various factors likely to influence the value of any property, discussing their degrees of importance. 8000 w. Eng Rec—Aug. 5, 1905. No. 71242.

River Water.

Tastes and Odors in River Water Supplies. Information collected by Mr. Dow R. Gwinn, showing that the evil is widespread. 1500 w. Eng News—Aug. 3, 1905. No. 71178.

WATERWAYS AND HARBORS.

Buenos Ayres.

The Port of Buenos Ayres (Le Port de Buenos Aires). Auguste Moreau. A review of the Huergo project for the improvement of the harbor at Madero. 5000 w. 1 plate. Mem Soc Ing Civ de France—April, 1905. No. 71595 G.

Canal Lift.

The Electric Portion of a Canal Lift System (Der Elektrische Teil der Weltbewerbsarbeiten für ein Kanal Schiffshebewerk). Ernst Kronstein. A description of the electrical portion of an inclined-plane canal lift proposed for the Danube—Oder canal scheme. 4000 w. Zeitschr f Elektrotechnik—July 30, 1905. No. 71574 D.

Canals.

Canada's Canal System. M. M. Wilner. An illustrated account of the canals along the St. Lawrence river, around Niagara Falls, and connecting the Great

Lakes. 3500 w. Rev of Revs—Aug., 1905. No. 71121 C.

Canal Transport. Discusses the canals of Great Britain, their improvement, and the method of haulage, their cost, etc., especially illustrating and describing the method of electric traction employed on the Teltow Canal. Also editorial. 4000 w. Ir and Coal Trds Rev—Aug. 4, 1905. No. 71341 A.

Sault Canal Celebration. An account of the celebration of the nftieth anniversary, with the historical address of Hon. Peter White. Ills. 8000 w. Marine Rev—Aug. 3, 1905. No. 71208.

Sault Canal Celebration. An illustrated article giving particulars of the exercises and the addresses of Gov. Fred M. Warner and Vice-President Fairbanks, and extracts from other addresses. 6000 w. Marine Rev—Aug. 10, 1905. No. 71310.

The Actual Problems of the Panama Canal. John F. Wallace. The first of a series of critical articles discussing the plans and methods of execution of the works at the isthmus. 4500 w. Engineering Magazine—September, 1905. No. 71654 B.

The Improvement of the Ohio Canals. W. Frank McClure. A brief account of improvements to create a new deep water link between Lake Erie and the Ohio River, with illustration of the weigh-lock of the Ohio and Erie canal. 900 w. Sci Am—Aug. 5, 1905. No. 71184.

The Semi-centennial of St. Mary's Falls Canal. An illustrated article briefly reviewing the history of the regime and the construction of the canal and its development. 1500 w. Naut Gaz—Aug. 3, 1905. No. 71211.

The Semi-Centennial of the Soo Canal. Illustrates the first lock constructed in America, and the present locks of the Sault Ste. Marie Canal, giving some information concerning the immense traffic. 800 w. Marine Engng—Aug., 1905. No. 71119 C.

The Value of Our Canals, and What We Ought to do With Them. Discusses the British canal situation. 3000 w. Elec Rev, Lond—Aug. 18, 1905. No. 71629 A.

Coal Pockets.

Coal Pockets in the Harbor of Hamburg (Kohlenkipper im Hamburger Hafen). Describing the newly installed appliances for handling coal for the vessels of the Hamburg-American Line at Hamburg. 1500 w. Zeitschr d Ver Deutscher Ing—July 29, 1905. No. 71508 D.

Cranes.

Electrically Driven Harbor Crane (Elektrisch Betriebener Werft-Drehkran). Illustrating and describing a 120 ton radical harbor crane, constructed for the Austrian Lloyds. 3000 w. 1 Plate. Zeitschr d Ver Deutscher Ing—Aug. 5, 1905. No. 71509 D.

The Electric Cranes in the Harbor of Cologne and Deutz (Die Elektrisch Betriebenen Krane im Cöln-Deutzer Hafen). Kurt Perlewitz. With views and details of the traveling portal cranes used on the Rhine front, using the 50 cycle current of the city supply direct. 3500 w. Elektrotech Zeitschr—Aug. 10, 1905. No. 71564 B.

Electric Power.

The Electrical Equipment of Manaos Harbor, Amazon River. Charles J. Seibert. A short illustrated description of a system for handling cargo, which has proved very successful. 1200 w. Elec Wld & Engr—Aug. 19, 1905. No. 71436.

Flow.

The Irregular Flow of Rivers in Humid Prairie States. F. W. Hanna. In the opinion of the writer, the changes under discussion have been caused by pasturage, drainage, and cultivation mainly. 1500 w. Eng News—Aug. 3, 1905. No. 71179.

Harbors.

Fishguard Harbor Works. H. G. Archer. Illustrated description of the harbor works for the Irish service of the Great Western Railway. This new route will shorten the distance 100 miles in many cases between places in England and Ireland. 2000 w. Engng—Aug. 11, 1905. No. 71461 A.

River Improvement.

Land Reclamation Along the Illinois River. Describes the method used in reclaiming large tracts of land on both sides of the Illinois River, and the flood protection of ten tracts varying from 3000 to 15000 acres each. Ills. 1500 w. Eng Rec—Aug. 5, 1905. No. 71239.

Sea Walls.

Some Notes on Sea Protective Works on the North Coast of Jamaica. J. Monk Fletcher. An explanation of conditions and description of repair work. 1500 w. Eng Rec—Aug. 5, 1905. No. 71237.

The Great Sea Wall at Galveston. W. S. Hudson. Brief illustrated description of this recently completed great sea wall. 1000 w. Sci Am—Aug. 26, 1905. No. 71486.

Shears.

Heavy German Shears and Presses. Frank C. Perkins. Illustrated descriptions of large machines operated by hydraulic and steam power. 2400 w. Ir Age—Aug. 17, 1905. No. 71374.

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ELECTRICAL ENGINEERING

COMMUNICATION.

Africa.

The Telegraph Lines of Africa (Die Telegraphenlinien in Afrika). Hans V. Hellrigl. A review of the existing lines and those under construction. 2000 w. Zeitschr f Elektrotechnik—Aug. 6, 1905. No. 71577 D.

Autotelegraph.

The Cerebotani Autotelegraph. Illustrated description of this apparatus for the telegraphic transmission of writing and its operation. 1400 w. Sci Am Sup—Aug. 5, 1905. No. 71188.

Cables.

Submarine Cables (Ueber Unterseekabel). Hermann Hilderbrandt. A general review of the growth of the submarine cable service of various parts of the world. Serial. Part I. 2500 w. Schiffbau—Aug. 9, 1905. No. 71592 D.

Space Telegraphy.

Governmental Wireless Telegraphy on the Pacific Coast. Waldon Fawcett. An account of recent extensions, and report of successful long-distance transmission, and some idea of the commercial messages transmitted. Ills. 800 w. Elec Rev, N Y—Aug. 5, 1905. No. 71213.

Massic System of Wireless Telegraphy. A. Frederick Collins. An illustrated description of the apparatus used. The chief features relate to the receptor and a controlling device for switching in and out simultaneously the oscillophone, the transformer and the motor-generator. 1800 w. Elec Wld & Engr—July 29, 1905. No. 71134.

Subsidiary Apparatus of the Telefunken System. A. Frederick Collins. Describes changes that were necessary in the devices used in this combination system of wireless telegraphy, illustrating the field outfit, and other apparatus. 2000 w. Elec Wld & Engr—Aug. 12, 1905. No. 71328.

The Artom System of Directed Wireless Telegraphy (Richtfähige Telegraphie ohne Draht nach Artom). Describing the successful application of the principle of Righi for projecting electrical oscillations in a single right-line direction. 1500 w. Elektrotech Zeitschr—Aug. 3, 1905. No. 71562 B.

The Metallic Point Electrolytic Detector (Le Détecteur Electrolytique à Pointe Métallique). G. Ferrié. Showing the manner in which a device consisting of a platinum point in imperfect contact with an electrolyte such as sulphuric acid may be used to receive Hertzian waves. 1000 w. Comptes Rendus—July 31, 1905. No. 71527 D.

Wireless Telegraphy Measurements. W. Duddell and J. E. Taylor. Read before the Inst. of Elec. Engrs. an account of preliminary tests made by the authors for the Postal Telegraph Department to measure the R. M. S. value of the current in the receiving air wire and to determine, as far as possible, how this current depends on the arrangement of the transmitting and receiving apparatus and the distance between them. Ills. 2500 w. Elec Engr, Lond—Aug. 11, 1905. Serial. 1st part. No. 71455 A.

Telephony.

An Austrian Inductive Telephone Trunk Line. Abstract translation of an article by Herr R. Nowotny, describing a successful experiment made in Austria on the insertion of inductance coils in long telephone lines. Ills. 1700 w. Elect'n, Lond—Aug. 11, 1905. No. 71458 A.

Development and Future Tendencies of the Telephone Art. Edward E. Clement. Abstract of a paper prepared for the Nat. Interstate Tel. Assn. A review of past and present practices, and a brief discussion of improvements and changes to be expected. 2500 w. Elec Rev, N Y—Aug. 19, 1905. No. 71431.

Safety Appliances for Use with Weak Currents (Beitrag zur Konstruktion Elektrischer Sicherungen für Schwachstromanlagen). Hans Carl Steidle. Describing a device to protect the user of a telephone from the action of atmospheric discharges. 1200 w. Elektrotech Zeitschr—July 20, 1905. No. 71558 B.

Telephone Service and Rates in New York. Extracts from the report made by the Merchants' Association on this question. 6000 w. Elec Rev. N Y—Aug. 5, 1905. No. 71214.

The Central Battery System in the Austrian Telephone Exchange (Das Zentral Batterie System in Oesterreichischen Telephon Zentralen). Emil Müller. A general description of the modern equipment of telephone exchanges in Austria. Three articles. 7500 w. Zeitschr f Elektrotechnik—July 9, 16, 23, 1905. No. 71572 each D.

The Railway Telephone Service; Cost of Line Construction. Frank F. Fowle. A discussion of the cost of construction, maintenance and operation and matters relating to economy in the operation of railways. 5500 w. Tech Qr—June, 1905. No. 71146 E.

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Transfer Systems and the Multiple Board in Telephone Exchanges. Arthur V. Abbott. This opening article explains these two systems. 1800 w. Elec Wld & Engr—July 29, 1905. Serial. 1st part. No. 71135.

DISTRIBUTION.

Circuits.

A Study of Circuits Containing Resistance, Inductance, and Capacity by Means of the Circle-Diagram. J. S. Dow and F. Creedy. An attempt to apply the circle-diagram to the study of circuits containing resistance, self-induction, and capacity. 2200 w. Elec Engr, Lond—Aug. 4, 1905. No. 71354 A.

Three-Wire.

Three-Wire Distribution for Factories. Ralph W. Birkett. Remarks on the advantages of a three-wire system, describing one installed by the author at a large engineering works. 4000 w. Elect'n, Lond—July 21, 1905. No. 71159 A.

Transformers.

A Simple Graphical Method of Determining the Pressure Drop in Transformers (Ueber eine Einfache Graphische Ermittelung des Spannungsabfalles bei Transformatoren). Walter Hahnemann. Showing the application of the circular diagram of Kapp, giving results within 10 per cent. 1500 w. Elektrotech Zeitschr—July 27, 1905. No. 71560 B.

Central Station Transformer Testing. William Nesbit. Gives directions for making the copper loss test, regulation test, ratio test, and insulation test. 2200 w. Elec Jour—Aug. 1905. No. 71315.

Transformers. R. T. MacKeen. Read before the Can. Elec. Assn. A general discussion upon the characteristics of lighting and power transformers as used for pole suspension in sizes limited to 50 K W. and less. 5000 w. Can Elec News—Aug. 1905. No. 71489.

ELECTRO-CHEMISTRY.

Accumulator.

The Edison Nickel-Iron Storage Battery (Der Eisen-Nickelakkumulator nach System Edison). M. U. Schoop. A very full description of the latest type of Edison alkaline accumulator, with data and results of tests. 8000 w. Elektrotech Zeitschr—Aug. 17, 1905. No. 71569 B.

Electric Furnaces.

Accessory Equipment of Electric-Furnace Plants. M. M. Green. Discusses the raw materials and various stages of manufacture. 2000 w. Eng & Min Jour—Aug. 26, 1905. No. 71603.

Electrically-Heated Carbon Tube Furnaces. R. S. Hutton and W. H. Patterson. Read before the Faraday Soc. An illustrated account of the authors' work with there furnaces and the results. 2500 w. Sci Am Sup—Aug. 19, 1905. Serial. 1st part. No. 71395.

Industrial Resistance Furnaces. F. A. J. FitzGerald. Considers the Gin, Colby, and Kjellin furnaces. Ills. 1500 w. Elec-Chem & Met Ind—Aug. 1905. No. 71272 C.

The Electric Furnace in Steel Making. Extract from an article by F. W. Harbord, in the London *Times*, concerning the place the electric furnace may be expected to take in the British steel industry. 1800 w. Ir Age—Aug. 24, 1905. No. 71473.

The Galbraith Electric Furnace. Illustrates and describes a furnace designed to deal specially with the iron sands found in large quantities at Calliope Dock, Auckland, New Zealand, and elsewhere. 1200 w. Elec Engr, Lond—July 21, 1905. No. 71155 A.

The Refining of Steel in the Electric Furnace (Ueber Gewinnung von Stahl im Elektrischen Ofen). Viktor Engelhardt. A general review of electric smelting methods followed by a discussion of the Kjellin induction furnace. Serial. Part I. 2000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Aug. 5, 1905. No. 71551 D.

Electrolytic Analysis.

Suggestions for the Equipment of an Electro-Analytical Laboratory. Dr. Rudolf Gahl. Read before the W. Assn. of Tech. Chem. & Met. Discusses the electrical current and how best to produce it, and the application of this system for practical use. 2500 w. Min Rept—Aug. 10, 1905. No. 71321.

Electro-Metallurgy.

The Rapid Electro-Deposition of Copper. Sherard Cowper-Coles. Read before the Faraday Soc. An illustrated discussion of the various processes tried for increasing the current desired by using mechanical means for keeping the copper from getting rough. 2200 w. Min Jour—Aug. 5, 1905. Serial. 1st part. No. 71344 A.

Electroplating.

The Chemistry of Electroplating. Wilder D. Bancroft. Presents the most recent facts relating to the electrolytic precipitation of the metals. 2500 w. Jour Fr Inst—Aug. 1905. No. 71294 D.

Electrotyping.

Electrotyping. Dr. F. Mollwo Perkin, in *Knowledge and Scientific News*. Describes the processes of electrotyping, facing and stereotypes, reproduction of gramophone records, etc. 1700 w. Sci Am Sup—Aug. 5, 1905. No. 71187.

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Formulae.

On the Fundamental Formulæ of Chemical and Electrical Energy. Prof. F. Haber. Notes these different stages in the development of knowledge of the relation between heat of reaction and energy of reaction, discussing each and especially considering the simplification possible. 1500 w. Elec-Chem & Met Ind—Aug., 1905. No. 71270 C.

Ozone.

Improvements in the Electrical Generation of Ozone (Neuerungen auf dem Gebiete der Erzeugung des Ozons auf Elektrischem Wege). Dr. O. Kausch. A review of recent patents, with illustrations and details of apparatus. Two articles. 3000 w. Elektrochemische Zeitschr—July, Aug., 1905. No. 71593 each G.

Metallic Arc.

The Electrochemistry of the Metallic Arc. Isador Ladoff. The object of the article is to review the literature treating of the metallic arc, and to give the results of the writers' work in this field. 1800 w. Elec-Chem & Met Ind—Aug., 1905. Serial. 1st part. No. 71273 C.

Ozone.

The Production and Utilization of Ozone. Arthur W. Ewell. Explains three methods of producing ozone, referring to a number of ozonizers, and to applications made of ozone. 1800 w. Elec Wld & Engr—Aug. 12, 1905. No. 71327.

Raw Materials.

The Sources of Raw Materials for Niagara's Electrochemical Industries. Morris M. Green. Discusses in detail the most convenient sources and the approximate cost of the salt, coke, pure glass sand, anthracite coal, and lime used. 800 w. Elec-Chem & Met Ind—Aug., 1904. No. 71271 C.

ELECTRO-PHYSICS.

Dielectrics.

A Contribution to the Study of Liquid Dielectrics (Contribution à l'Etude des Dielectriques Liquides). P. Gourée de illemontée. Experiments upon the behavior of petroleum and of paraffine oil when used as a dielectric in electrical condensers. 1200 w. Comptes Rendus—July 17, 1905. No. 71525 D.

Eddy Currents.

Eddy-Current Losses in the Armature Copper of Electrical Machines (Wirbelstromverluste im Ankerkupfer Elektrischer Maschinen). Bruno Loewenherz and A. H. van der Hoop. A description of experimental investigations, the results being plotted in curves. 3000 w. Elektrotech Zeitschr—Aug. 17, 1905. No. 71570 B.

Hysteresis.

Experiments on the Work of the Iron in Polyphase and Alternating Fields (Versuche über die Eisenarbeit im Dreh und Wechselfeld). J. Herrmann. Experiments to show the relative hysteresis loss in polyphase and linear alternating fields. 3500 w. Elektrotech Zeitschr—Aug. 10, 1905. No. 71565 B.

Radioactivity.

Some Experiments Upon the Radioactivity of Uranium (Sur quelques Expériences Relatives à l'Activation par l'Uranium). Henri Becquerel. Results of experiments with uranium salts under various conditions of temperature. 1800 w. Comptes Rendus—July 10, 1905. No. 71523 D.

Rectifier.

The Influence of the Electrolyte upon the Action of the Aluminum Rectifying Cell (Der Einfluss des Elektrolyten auf die Wirksamkeit der Aluminum Drosselzelle). Dr. Franz Peters and Dr. A. E. Lange. Describing experiments with the electrolytic cell for rectifying alternating currents; extending the researches of Mott. 2500 w. Elektrotech Zeitschr—Aug. 10, 1905. No. 71566 B.

Solenoids.

The Mechanical Efficiency of Solenoid Magnets (Die Mechanische Arbeitsleistung von Hubmagneten). Paul Schieman. An application of the law of the conservation of energy to the performance plunger armatures in solenoid coils. 1500 w. Zeitschr f Elektrotech—Aug. 13, 1905. No. 71578 D.

GENERATING STATIONS.

Armature Losses.

Armature Losses in Double-Current Generators. Alfred Still. Gives diagrams showing what takes place in the armature windings of a double-current generator, with explanation. 1600 w. Elec Wld & Engr—Aug. 12, 1905. No. 71326.

Clyde.

The Clyde Valley Electrical Power System, Glasgow, Scotland. Illustrated description of the Yoker generating plant, with an outline of the power scheme to serve the most important manufacturing and coal producing district of Scotland. 2200 w. Elec Wld & Engr—Aug. 5, 1905. No. 71233.

Dynamos.

Acyclic Dynamos (Les Dynamos Acycliques). A general review of the homopolar type of dynamos, generating continuous currents without commutators and especially adapted for high rotative speeds. 2500 w. Génie Civil—July 29, 1905. No. 71519 D.

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Continuous-Current Dynamos with Auxiliary Poles (Gleichstrommaschinen mit Hülfspolen). Max Breslauer. Experiments to determine the proper dimensions of commutation poles. 6000 w. Elektrotech Zeitschr—July 13, 1905. No. 71555 B.

Labor Saving Formulæ. Julius Frith. Gives examples illustrating the use of formulæ in the design of direct current dynamos, especially with regard to high speeds. 1800 w. Elec Engr, Lond—Aug. 4, 1905. No. 71357 A.

Notes on Pole Changing Machines (Bemerkungen über Wendepolmaschinen). A. Rotth. Comparative results obtained with two and four-pole dynamos with change magnets between the field magnets. 1500 w. Zeitschr f Elektrotechnik—Aug. 6, 1905. No. 71576 D.

Electric Plants.

Some Suggestions on Operation and Construction in the Electric Department. George C. Holberton. Read before the Pacific Coast Gas Assn. General suggestions on the selection and care of meters, the character of the service, etc. 3500 w. Jour of Elec—Aug., 1905. No. 71419 C.

Gas Power.

Utilization of Gas Engines in Connection with Long Distance Electric Transmission. Jno. Martin. Read before the Pacific Coast Gas Assn. Brief account of the use of gas engines by the California Gas & Electric Corporation, describing the engines now being built. 2000 w. Jour of Elec—Aug., 1905. No. 71418 C.

Utilization of Gas Engines in Connection with Long-Distance Electric Transmission. John Martin. Read before the Pacific Coast Gas Assn. Information concerning the application of gas engines in California, in which the gas used is derived from crude oil. 2000 w. Elec Wld & Engr—Aug. 5, 1905. No. 71234.

Generating System.

Generating System of the Portland General Electric Co. F. G. Sykes. From a paper read before the Engineering Congress at the Lewis and Clark Exposition. Illustrated detailed description of the works. 3700 w. Eng Rec—Aug. 12, 1905. No. 71331.

Hydro-Electric.

Electric Power Developments at Niagara Falls. Gives a view showing the location of the new power plants with reference to the Falls, and begins an illustrated description of the plant of the Ontario Development Company. 2500 w. Sci Am—Aug. 12, 1905. Serial. 1st part. No. 71282.

Electric Power Development at Portland, Ore. Illustrated description of the new station of the Portland General Electric Co., at Willamette Falls. 1600 w. Elec Wld & Engr—July 29, 1905. No. 71133.

Hydro Electric Developments of the Ontario Power Company. Begins an illustrated detailed description. The present number outlines the general plan and describes the intake works. 3000 w. Elec Wld & Engr—Aug. 26, 1905. Serial. 1st part. No. 71614.

Hydro-Electric Development in Norway. L. Ramakers. An illustrated description of the electric generating station at Glommen, near Kykkelsrud. 1500 w. Am Electr'n—Aug., 1905. No. 71147.

Hydro-Electric Power Station, California Gas & Electric Corporation, de Sabla, Cal. Illustrated detailed description of a power station, having a generator of 5000-K W. capactity, run by a single water wheel operating under a static head of water of 1528 ft. 3000 w. Eng News—Aug. 10, 1905. No. 71274.

Some of the Electrical Developments in Oregon. C. M. Hyckell. Illustrates and describes various projects for the utilization of water power. 2000 w. Elec Rev, N Y—Aug. 12, 1905. No. 71309.

The Hydro-Electric Plant at Beznau. C. L. Durand. An illustrated description of an important Swiss central supply station. 1500 w. Elec Rev, N Y—Aug. 19, 1905. No. 71434.

Lighting Station.

The Electric Station of the Baden State Railways at Durlach (Das Elektrizitätswerk der Badische Staatseisenbahnen bei Durlach). K. Freyss. An illustrated description of the new station furnishing current for lighting the buildings of the Baden railway system. 3500 w. Elektrotech Zeitschr—Aug. 10, 1905. No. 71567 B.

The System of the Portland General Electric Company. F. G. Sykes. A general review of the development of electricity in Portland, and a fully illustrated description of the plant deriving more than 30,000 h. p. from the falls of the Willamette River and transmitted electrically to Portland. 10800 w. Jour of Elec—Aug., 1905. No. 71417 C.

Parallel Running.

"Flywheel Effect" and "Stored Energy" in Rotating Parts of Electrical Machinery, and the Parallel Running of Alternators. Compares English and Continental practise, and the conversion of one system to the other is explained, giving example. 2000 w. Elec Engr, Lond—Aug. 18, 1905. No. 71628 A.

Operation of Alternators in Parallel. A. L. Mudge. Read before the Can. Elec.

We supply copies of these articles. See page 159.

Assn. Considers some of the advantages secured by parallel operation, the requirements, and points in practical operation. 7500 w. Can Elec News—Aug., 1905. No. 71490.

Power Station.

Steel Work of the Marion Power Station, Public Service Corporation of New Jersey. Illustrated description of a power house in Jersey City, designed for an installation of boilers and Curtis Turbo-Generators of about 64,000 K W. ultimate capacity. 1800 w. Eng Rec—Aug. 19, 1905. No. 71441.

Pressure.

The Kinetic Variation of Pressure in Electric Generators. Alexander Russell. Points out that it is inconsistent to specify the drop in the terminal pressure of electric generators from no-load to full-load without stating the rate at which the voltage shall decrease with the speed. Gives a method of finding the kinetic factor. 2000 w. Elect'n, Lond—Aug. 4, 1905. No. 71358 A.

Pull.

The Lateral Magnetic Pull of Dynamos and Motors (Der Einseitige Magnetische Zug von Dynamos und Motoren). F. Niethammer. Deriving formulas for computing the lateral magnetic effort due to eccentricity in construction. 1000 w. Zeitschr f Elektrotechnik—July 9, 1905. No. 71571 D.

Venice.

The Electric Station at Venice (Das Elektrizitätswerk Venedig). F. Niethammer. A general description of the Cellina hydro-electric station, supplying the city of Venice with current for light and power. 2000 w. 2 plates. Zeitschr f Elektrotechnik—Aug. 6, 1905. No. 71575 D.

LIGHTING.

Illuminated Signs.

Sign and Decorative Lighting. La Rue Vredenburgh. Deals only with the commercial side of the subject. 2500 w. Cent Sta—Aug., 1905. No. 71267.

Lighting Station.

See Electrical Engineering, Generating Stations.

Nernst.

Inter-Relation of Ballast and Glower in the Nernst Lamp. Lewis A. Terven. An outline study of the problems presented by the glower and the ballast showing how they combine to make the lamp. 2500 w. Elec Wld & Engr—Aug. 19, 1905. No. 71435.

Photometry.

The Photometry of Unsymmetrical Sources of Light (Ueber die Photometrie Unsymmetrischer Lichtquellen). L. Bloch. Showing how the observation of a limited number of values will enable a fair average result to be obtained. 1800 w. Elektrotech Zeitschr—July 13, 1905. No. 71556 B.

Street Lighting.

Street Lighting by Incandescent Lamps. John Howatt. Describes briefly the two general systems used in operating incandescent lamps for street lighting. 1400 w. Am Elect'n—Aug., 1905. No. 71149.

Subway Lighting.

The Illumination of the Subway Stations. E. Leavenworth Elliott. Discusses the faults of the present system of lighting the New York Subway, and the means of overcoming them. 2500 w. Elec Rev, N Y—Aug. 26, 1905. No. 71498.

MEASUREMENT.

Galvanometers.

Marine Galvanometer and Adjustable Universal Shunt Used as a Direct-Reading Milammeter or Voltmeter. J. Rymer-Jones. Gives particulars showing how a galvanometer may be employed as a very sensitive milammeter, and also for a sensitive voltmeter. 1800 w. Elec Rev, Lond—Aug. 11, 1905. No. 71456 A.

High Temperatures.

The Electrical Measurement of High Temperatures. H. S. Knowlton. Explains the merits of the Le Chatelier pyrometer. 900 w. Cassier's Mag—Aug., 1905. No. 71385 B.

Measuring Instruments.

Discussion on Measuring Instruments at Philadelphia, May 8, 1905; Pittsburg, Pa., May 8, 1905; and San Francisco, May 9, 1905. 7000 w. Am Inst of Elec Engrs—Aug., 1905. No. 71404 D.

The Handling of Electrical Instruments in Relation to Their Accuracy. H. B. Taylor. Discusses the location of instruments where they will not be affected by other pieces of apparatus or by the conducting current. Considers the stray magnetic field, correction for energy losses, zero errors, and the precautions necessary in handling. 3500 w. Elec Jour—Aug., 1905. No. 71316.

Meters.

Discussion on "Some Notes on Polyphase Metering," "Notes on the Use of Instruments on Switchboards," and "Maintenance of Meters," at New York, April 28, 1905. 5000 w. Am Inst of Elec Engrs—Aug., 1905. No. 71403 D.

Oscillograph.

The Siemens & Halske Oscillograph (Der Ozillograph der Siemens & Halske Aktiengesellschaft). W. Hornauer. A description of the apparatus with repro-

ductions of the curves produced by various types of generators. Two articles. 5000 w. Zeitschr f Elektrotechnik—July 16, 23, 1905. No. 71573 each D.

Wave Lengths.

The Measurement of the Wave Lengths of Electric Oscillations (Ueber die Messung der Wellenlänge Elektrischer Schwingungen). E. Gehrcke. Describing the apparatus and methods used at the Physikalisch Technisch Reichsanstalt. 3000 w. Elektrotech Zeitschr—July 27, 1905. No. 71559 B.

MOTORS.

Commutation.

Reactance E. M. F. and the Design of Commutating Machines. C. A. Adams. Explains a formula developed by the writer which makes possible a rational determination of the minimum safe number of commutator bars, and shows the manner in which the several fundamental design constants affect the commutation. 2000 w. Elec Wld & Engr—Aug. 26, 1905. No. 71615.

Induction Motors.

The Design of Induction Motors. H. M. Hobart. The first of a series of articles giving a consistent plan of design. 600 w. Elec Mag—July 29, 1905. Serial. 1st part. No. 71382 A.

Motors.

A Traction Motor for Continuous and Alternating Current. Describes a car equipped with the Winter-Eichberg motors, which can be driven either by continuous or alternating-current. From the *Elektrotechnische Zeitschrift*. Ills. 1000 w. Elec Engr, Lond—Aug. 4, 1905. No. 71356 A.

Winter-Eichberg.

The Theory of the Winter-Eichberg Motor (Zur Theorie des Winter-Eichberg Motors). Dr. L. Fleischmann. Giving both graphical and analytical treatment, and deriving equations for the computation of the turning moment. 2500 w. Elektrotech Zeitschr—Aug. 17, 1905. No. 71568 B.

TRANSMISSION.

Lightning Arresters.

Protective Apparatus. N. J. Neall. Illustrates various types of lightning arresters, discussing present American practice for high voltage transmission circuits. 3000 w. Elec Jour—Aug., 1905 No. 71317.

High Voltage.

A French 28,000-Volt Power Transmission. Illustrated description of a high-voltage plant recently placed in service to supply power to Toulon. 2400 w. Elec Rev, Lond—July 21, 1905. No. 71157 A.

Lines.

Notes on Aerial Power Lines. Considers the problems underlying the elementary principles of the construction of line wires and their supports. 1500 w. Elec Engr, Lond—Aug. 11, 1905. Serial. 1st part. No. 71453 A.

Long Distance.

Conductors for Long-Distance High-Voltage Alternating Currents (Die Fernleitung Hochgespannter Wechselstrome). G. Rössler. With diagrams for the proportions of conductors, and tables of results for various distances. 6000 w. Elektrotech Zeitschr—Aug. 3, 1905. No. 71563 B.

Towers.

The Use of Steel Towers and Wooden Poles. Alton D. Adams. Notes the growing use of steel towers to support long distance transmission lines, giving examples of both kinds of line construction, and their approximate cost, and the advantages claimed for steel towers. Ills. 3300 w. Elec Rev, N Y—Aug. 19, 1905. No. 71432.

INDUSTRIAL ECONOMY

Cost Keeping.

Cost Keeping in Construction and Contract Work. John P. Cowing. A description of the practical methods employed in keeping the cost accounts in bridge construction work, with forms and records. 2000 w. Engineering Magazine—Sep., 1905. No. 71661 B.

Education.

Commercial Training for Engineers. R. D. Summerfield. Outlines the training the writer considers essential for a successful engineer, especially the importance of a business education. 2000 w. Engng—Aug. 18, 1905. No. 71631 A.

Professional Instruction in Public Works (L'Enseignement Professionnel des Travaux Publics). Col. G. Espitallier. A description of the school at Paris and the annex now being constructed at Arcueil. 3000 w. 1 plate. Génie Civil—Aug. 12, 1905. No. 71521 D.

Technical Education for Foundrymen. Prof. A. Humboldt Sexton. Read before the British Found. Assn. Discusses the subjects that should be included, and the

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advantages and value of the education acquired. 2800 w. Mech Engr—Aug. 19, 1905. No. 71626 A.

The Practical Utility of Manual and Technical Training. William Barclay Parsons. An address before the Nat. Ed. Assn. Discussing the subject from the point of view of results achieved and of ends to be attained. 3800 w. Eng Rec—Aug. 12, 1905. No. 71333.

Exposition.

The Lewis and Clark Exposition. Waldron Fawcett. Illustrated description of the grounds and buildings of the several States, with special reference to the mining exhibits. 4200 w. Mines & Min—Aug., 1905. No. 71202 C.

The Liége Exhibition. Remarks on the exhibition as a whole, and the lessons which it can convey. 3000 w. Engr, Lond—Aug. 11, 1905. Nofl 71465 A.

The Liége International Exposition (L'Exposition Internationale de Liége). L. Ramakers. A fully illustrated description, with plan and views of the various buildings. 3000 w. Génie Civil—July 22, 1905. No. 71515 D.

Japan.

Japanese Industrial Conditions. The first of a series of articles on the recent progress and future prospects of Japan. The present number discusses the coal-mining, and the development of the mining industry. Also editorial. 3000 w. Ir & Coal Trds Rev—July 28, 1905. Serial. 1st part. No. 71260 A.

Municipal Plants.

Financial Results of Municipal Electric Plants (Finanzielle Ergebnisse Städtischer Elektrizitätswerke). Fritz Hoppe. A review of the commercial operation of electric plants in the various cities of Germany, based on data for 1903. 7500 w. Elektrotech Zeitschr—July 20, 1905. No. 71557 B.

Rates.

Regulation of Gas and Electric Rates in Massachusetts. Alton D. Adams. Gives a collection of cases, involving gas and electric rates, which have come before the Massachusetts Commissioners, giving the facts that determined the rates, and the reasons, without any expression of opinion. 2200 w. Elec Wld & Engr—Aug. 19, 1905. Serial. 1st part. No. 71437.

Shop Superintendent.

The Training of the Modern Shop Superintendent. Charles C. Johnson. On the training given at technical schools, considering it as practical and in some ways superior to anything possible at a workshop. Ills. 1800 w. Sci Am—Aug. 26, 1905. No. 71485.

Society.

The Development and Work of the Society of German Engineers (Entwicklung und Leistungen des Vereines Deutscher Ingenieure). H. Peters. A review of the formation and growth of the organization, and the important work it has accomplished. Two articles. 4500 w. Zeitschr d Ver Deutscher Ing—July 15, 22, 1905. No. 71506 each D.

Stock-Keeping.

A Perfect Method of Stock-Keeping. J. P. Wiatt. Gives a method which the writer considers the best and most accurate system of keeping stock. 1200 w. Jour Gas Lgt—Aug. 1, 1905. No. 71343 A.

MARINE AND NAVAL ENGINEERING

Arctic Service.

Propelling Machinery for the Arctic Steamer Roosevelt. An illustrated article giving a general description of the machinery designed to meet the severe conditions of working through the ice. 1800 w. Marine Engng—Aug., 1905. No. 71117 C.

Disasters.

General Pando Hoodoo. E. Cockburn Johnstone. An interesting account of the fate of a vessel built for Bolivia, which never reached its destination. 1800 w. Marine Rev—Aug. 3, 1905. No. 71210.

Electric Power.

Application of Electric Power to Auxiliary Machinery in the Navy. L. C. Brooks. Describes the latest practice in the various applications made. Ills. 5000 w. Am Elect'n—Aug., 1905. No. 71148.

Ferryboats.

The Southern Pacific Company in Marine Work. W. H. Crawford and T. B. Burnite. Illustrated description of the train ferryboat "Solano" and its recent repairing on a specially built marine railway and of car floats on San Francisco Bay. 1500 w. Marine Engng—Sept., 1905. No. 71650 C.

The New Staten Island Ferryboats. Brief general description, with illustrations, of the ferryboat "Manhattan," 250 feet long, with a speed of 18½ knots. 400 w. Marine Engng—Sept., 1905. No. 71652 C.

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Fire-Boat.

The Fire-Boat George H. Williams, of Portland, Oregon. General description, with illustrations, of a successful fire-boat which has been in service about one year. 1400 w. Marine Engng—Aug., 1905. No. 71118 C.

Fishing Boats.

Foreign Types of Fishing Boats in San Francisco Bay. E. N. Percy. Brief illustrated descriptions of unique types, including a Chinese junk, and an Italian fishing boat. 600 w. Marine Engng—Aug., 1905. No. 71116 C.

Gas Engines.

See Mechanical Engineering, Combustion Motors.

Lake Vessels.

The New Fleet on the Great Lakes. Ralph D. Williams. Gives information showing how the trade of the Great Lakes is growing and giving a list of this year's orders for new ships. Ills. 1300 w. R R Gaz—Vol. XXXIX. No. 5. No. 71226.

What of Our Commerce? Lewis M. Haupt. Gives a chart showing graphically the growth in traffic through this canal, and comparison with the Suez Canal, and urges the further improvement of these waterways. 1000 w. Marine Rev—Aug. 3, 1905. No. 71209.

Mercantile Marine.

New Passenger Steamer La Provence. L. Ramakers. Illustrated description of a new passenger steamer for service between Havre and New York, which will be the fastest and largest of the French mercantile marine. 1400 w. Marine Engng—Aug., 1905. No. 71115 C.

Models.

Experiments on Resistance of Ships' Models. G. Rota. Read before the Inst. of Naval Archts. Reports experiments with models of constant length and form of cross-sections, but with varying breadth and draught. 1500 w. Ills. Engng—Aug. 4, 1905. No. 71365 A.

Motor Boats.

Motor Yacht Club's Reliability Trials, 1905. Tabulated results, illustrations and interesting report of the second annual reliability trial for motor boats in Southampton Water and the Solent. 4800 w. Auto Jour—Aug. 12, 1905. No. 71447 A.

The New Auto-Boat Veritas. Illustrated description of 56-foot boat, with 8-cylinder gasoline engine of 175 horse power. 1500 w. Marine Engng—Sept., 1905. No. 71651 C.

Naval Ships.

Naval Ships at the Time of Trafalgar. Sir Philip Watts. Read before the Inst. of Naval Archts. Enumerates and classifies the types of ships forming the Royal Navy at that time, describing briefly the design, construction, armament, etc., of some of the more important. Ills. 4000 w. Engng—July 28, 1905. No. 71254 A.

Naval Strategy.

Naval Strategy and Tactics at the Time of Trafalgar. Admiral Sir Cyprian Bridge. Read before the Inst. of Naval Archts. Outlines the general plans and considers points which may furnish guidance of value at the present day. 5000 w. Engng—July 21, 1905. No. 71164 A.

Scouts.

Notes on the Trials of H. M. S. Adventure. Illustrates and describes this vessel, of the Scout class, and its equipment, giving tabulated results of the official trials. 2700 w. Engr, Lond—Aug. 4, 1905. No. Z1368 A.

The English Scout-Cruiser Sentinel. Emile Guarini. Illustrated general description of 25-knot, 2920-ton, 17500 horse power vessel, 340 feet long, built by Vickers Sons & Maxim, Ltd., and her trial trip. 800 w. Marine Engng—Sept., 1905. No. 71649 C.

Screw Propellers.

Rankine of the Screw Propeller. Reprint of an article appearing in this paper No. 2, 1866, setting forth the theory of the propulsion of vessels by jets. 1700 w. Engr, Lond—Aug. 4, 1905. No. 71373 A.

Shipbuilding.

The Dockyards and Shipbuilding Plants of Japan. Charles Albertson. A fully illustrated description of the facilities for shipbuilding at present existing in Japan. The first paper deals with the government yards. 3000 w. Engineering Magazine—Sept., 1905. No. 71656 B.

Sounding.

The Acoustic Method of Sounding (Procédés Acoustiques pour le Sondage). Ch. Dantin. A review of experiments made in the United States, England and Denmark for determining the depth of water by acoustic methods, and for submarine signalling between vessels. 1800 w. Génie Civil—July 22, 1905. No. 71517 D.

Speed.

The Influence of Depth of Water on the Speed of Destroyers. Harold Yarrow. Read before the Inst. of Naval Archts. An illustrated article discussing trials and experiments, having special reference to recently built destroyers. 1800 w. Engng—July 21, 1905. No. 71165 A.

The Influence of Depth of Water on Speed. W. W. Marriner. Read before the Inst. of Naval Archts. Gives deduc-

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tions drawn from recent and former experiments, especially investigating surface disturbance or wave-making resistance. 2000 w. Engng—July 21, 1905. No. 71166 A.

Submarines.

Submarine Boats and Their Salvage. Capt. R. H. Bacon. Read before the Inst. of Naval Archts. Discusses the causes of accidents to submarine boats, the means of preventing their occurrence, and the methods of raising such vessels. Also editorial. 8000 w. Engng—July 28, 1905. No. 71255 A.

Turbine Propulsion.

Comparison of Turbines and Reciprocating Engines in Steamers. William Gray. Read before the Inst. of Naval Archts. Gives particulars in regard to the working of the Midland Railway Company's steamers for the Irish and Isle of Man service, two being fitted with turbines and two with reciprocating engines. 2000 n. Mech Engr—July 22, 1905. No. 71154 A.

Speedy English Turbine Steamer. Illustrates and describes the Viking, plying out of the port of Liverpool. Speed about 27 miles an hour. 1500 w. Naut Gaz—Aug. 10, 1905. No. 71320.

The Allen Line Turbine Steamers Victorian and Virginian. Benjamin Taylor. General illustrated description of 19½-knot, 12000 horse power, 10,600-ton, 540-foot vessels, plying between Liverpool and Montreal. 1000 w. Marine Engng—Sept., 1905. No. 71648 C.

The Turbine-Driven Channel Steamer Dieppe. Illustrated description of the vessel and its machinery, with results of the official trial and remarks. 2300 w. Engng—Aug. 18, 1905. No. 71632 A.

Turbines and Reciprocating Engines in the Midland Railway Company's Boats. William Gray. Read before the Inst. of Naval Archts. A comparison of the performances of vessels, two being fitted with reciprocating engines and two with Parsons marine turbines. 2500 w. Engng—Aug. 4, 1905. No. 71364 A.

MECHANICAL ENGINEERING

AUTOMOBILES.

Air Cooling.

Handling of an Air-Cooled Gasoline Car. Harry B. Haines. Begins a detailed discussion of these cars and the care needed to handle them successfully. 1600 w. Automobile—Aug. 10, 1905. No. 71279.

Buckboard.

How to Make an Electric Buckboard. J. C. Brocksmith. An illustrated article giving directions for the construction. 1700 w. Am Elect'n—Aug., 1905. No. 71150.

Chassis.

The 40-horse power Georges-Richard-Brasier. Illustrated description of a chassis weighing 20 cwts. Completed entirely in accordance with Gordon Bennett practice. 700 w. Autocar—Aug. 19, 1905. No. 71627 A.

Commercial Vehicles.

Notes on the Use of Commercial Cars. Henri G. Chatain. Suggestions for the proper working of these cars, their care and operation. 2000 w. Automobile—Aug. 10, 1905. No. 71278.

Typical Commercial Vehicles on Sale. Gives information concerning the work of these cars, and illustrates and describes a number of types. 8000 w. Automobile—Aug. 10, 1905. No. 71277.

Delaunay-Belleville.

The Delaunay-Belleville Petrol Cars. Illustrated description of these cars. 700 w. Auto Jour—Aug. 5, 1905. Serial. 1st part. No. 71347 A.

Differential.

How a Differential Gear Works. Drawings and description explaining the action of a differential gear. 1500 w. Autocar—Aug. 5, 1905. No. 71348 A.

Electric Truck.

The Couple Gear Electric Truck. Illustrated detailed description of these motor vehicles. There is a motor in each wheel and each motor carries two pinions at the end of its shaft, meshing with bevel gear racks on the interior of the wheel frame. 1200 w. Ir Age—Aug. 10, 1905. No. 71244.

Fiat.

The 1905 Fiat Cars. Illustrates and describes late models, noting the changes made. 1100 w. Auto Jour—July 22, 1905. No. 71151 A.

Ignition.

Electric Ignition Systems. E. W. Roberts. General explanation of electric ignition systems, with brief illustrated descriptions of the several systems. 3000 w. Sci Am Sup—Aug. 19, 1905. No. 71304.

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Industrial Cars.

The French Heavy Car Trials. An account of the trials of commercial vehicles. 1500 w. Engr, Lond—Aug. 4, 1905. Serial. 1st part. No. 71370 A.

Tyres.

The Helena Tyre Outfit. Illustrates and describes a tyre detaching and attaching outfit. 1000 w. Autocar—July 22, 1905. No. 71152 A.

COMBUSTION MOTORS.

Efficiency.

"Mechanical Efficiency" in the Gas Engine. Editorial review of an interesting discussion that has been recently published in Germany concerning the meaning of the term "mechanical efficiency" in the case of gas engines. 4000 w. Eng News—Aug. 3, 1905. No. 71181.

Cylinders.

Size of Gas and Oil Engine Cylinders. Gives calculations for ordinary four-cycle single-acting engines. 700 w. Prac Engr —Aug. 11, 1905. No. 71450 A.

Gas Engines.

The Modern Gas Engine. F. E. Matthews. Reviews some of the early efforts to build gas engines, discusssing the essentials to efficiency, the operation of multiple-cycle engines, and other subjects of interest. Ills. 2200 w. Ice & Refrig —Aug., 1905. Serial. 1st part. No. 71215 C.

The Shops of the Joseph Reid Gas Engine Co., Oil City, Pa. Illustrates and describes the Reid gas engine, and the plant where it is manufactured. 2200 w. Ir Tr Rev—Aug. 3, 1905. No. 71199.

Gasoline Motors.

High-Power English Gasoline Motors for Driving American Locomotives. Describes two English motors being built for the General Electric Company, for a series of experiments with the gasoline-electric system of propulsion for locomotives. 1100 w. Sci Am Sup—Aug. 12, 1905. No. 71285.

Marine Engine.

Gas Engine with Producer for Marine Use. Illustrated description of a new type of mechanically-propelled vessel, constructed by John I. Thornycroft & Co., Ltd., and the machinery. 1500 w. Engng —Aug. 4, 1905. No. 71361 A.

HEATING AND COOLING.

Cooling.

Cooling the New York Stock Exchange. Illustrates and describes a system by which a continuous supply of fresh air is cooled and dried by apparatus of 450 tons refrigerating capacity. 2700 w. Met Work—Aug. 5, 1905. No. 71174.

Electric Heating.

Electric Heating and Cooling. George E. Walsh. States the advantages claimed for electricity in this field, and describes a number of applications for cooking, laundry work, in hospitals, etc. 3000 w. Archt's & Build's Mag—Aug., 1905. No. 71235 C.

Humidification.

Humidification in Textile Mills and Factories. H. R. Carter. States the advantages of a good humidifying system and illustrates the Drosophore humidifier as typical of local distribution humidifiers. 600 w. Prac Engr—Aug. 4, 1905. Serial. 1st part. No. 71350 A.

Japan.

A Warm Air Heating System in Kobe, Japan. Describes an installation having a large warm air cellar pipe and exhaust air ventilation passages. Ills. 2200 w. Met Work—Aug. 12, 1905. No. 71286.

N. Y. Custom House.

Heating and Ventilating New York's New Custom House. Illustrated detailed description of a notable type of the fan pressure system. 1700 w. Heat & Ven Mag—Aug., 1905. No. 71400.

Refrigeration.

Ice-Making by Electricity. Orrin E. Dunlop. Brief illustrated description of the electrically-operated ice-making plant at Niagara Falls. 900 w. Sci Am—Aug. 5, 1905. No. 71185.

Refrigeration for Office Buildings. Illustrates and describes the refrigerating plant of the First National Bank building in Chicago, and the refrigeration in the Heyworth building, run with exhaust steam. 2000 w. Ice & Refrig—Aug., 1905. No. 71216 C.

HYDRAULICS.

Flow.

The Resistance of Bends and Elbows in Pipes. Information concerning experimental investigations to determine the resistance offered by bends, knees and elbows in closed pipes, and the results. From a paper by C. W. L. Alexander, published by the Inst. of Civ Engrs. 2000 w. Eng Rec—Aug. 19, 1905. No. 71445.

Hydraulic Engines.

Hydraulic Engines at the U. S. Naval Coaling Station, Bradford, R. I. Illustrates and describes the Bradford installation. 1200 w. Eng News—Aug. 3, 1905. No. 71182.

Hydraulic Power.

Hydraulic Generation and Application of Motive Power. W. M. Barr. A review of modern hydraulic power development in the light of improved methods of regulation and application. 4000 w. Eng Mag—Sept., 1905. No. 71657 B.

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Niagara Power.

Power Sites About Niagara Falls. Alton D. Adams. Outlines a plan for utilizing the entire flow of the river, if desired, at a head of nearly ninety feet, and still leave the falls undiminished. 1500 w. Sci Am—Aug. 26, 1905. No. 71483.

The Intake of the Ontario Power Co. Illustrates and describes a structure built entirely of concrete, with reinforced concrete in a large part of the work, and the methods of construction. 1500 w. Eng Rec—Aug. 12, 1905. No. 71334.

Pressure Variations.

Pressure Variations in Turbine Supply Pipes (Druckschwankungen in Turbinenzuleitungsröhren). A. Budau. An exhaustive mathematical and practical investigation of the stresses in supply pipes and pen-stocks under sudden changes of flow, as in governing. Three articles. 12000 w. Zeitschr d Oesterr Ing u Arch Ver—July 21, 28, Aug. 4, 1905. No. 71535 each D.

Pumping Engine.

Pumping Engine, Rosario Water-Works. Illustrated description of a vertical triple-expansion pumping engine, working with high-pressure steam, moderately superheated. Describes also the arrangement and the advantages claimed, and gives report of test. 2000 w. Engr, Lond—Aug. 18, 1905. No. 71636 A.

Pumps.

Oil Pumps. A. L. Millar. Brief illustrated descriptions of types used in lubrication. 700 w. Am Mach—Vol. 28, No. 32. No. 71265.

Turbine Pumps.

Turbine Pumps for Irrigation and Drainage. J. J. Brown. Read before the Nat. Ir. Cong. at El Paso, Texas. Information concerning the cost of pump irrigation, giving brief reports from a number of places, and discussing various types of pumps. 2800 w. Jour of Elec—Aug., 1905. No. 71420 C.

Water-Power.

An Industrial Water-Power Plant at South Bend, Ind. Illustrated detailed description of the plant and its equipment. The governing arrangements are somewhat unusual. 1200 w. Elec Rev, N. Y. —Aug. 5, 1905. No. 71212.

MACHINE WORKS AND FOUNDRIES.

Castings.

Casting Brass or Bronze on to Iron. Walter J. May. An illustrated article giving hints that will give satisfactory results. 800 w. Prac Engr—Aug. 11, 1905. No. 71449 A.

Hot Cracks in Steel Castings. Arthur Simonson. The causes of hot cracks are explained, and ways of overcoming the difficulties are considered. 1400 w. Foundry—Aug., 1905. No. 71340.

The Presence of Sulphur in Cast Iron and its Influence on Machine Castings (Ueber die Schwefelverteilung in Gusstücken und deren Einfluss auf den Werkzeugmaschinenguss). A. Messerschmidt. Showing that the irregular distribution of sulphur in castings may cause serious local weaknesses. 3500 w. Stahl u Eisen —Aug. 1, 1905. No. 71584 D.

Cranes.

A Novel Electric Traveling Crane. Illustrated description of a novel crane in use at the yards of the Link Belt Engng. Co., Nicetown, Philadelphia, for loading and unloading cars, handling heavy castings and materials, etc. 900 w. Eng Rec —Aug. 26, 1905. No. 71624.

Electric 100-Ton Crane at Dublin. Illustrations and descriptive notes showing the general construction and electrical details of a new crane for the Port and Docks Board of Dublin. 1800 w. Elec Engr, Lond—Aug. 11, 1905. No. 71452 A.

Electric Traveling Hoists. Illustrates and describes a system of overhead traveling electric hoists, giving four views of the traveling transfer trolley service of the Ramapo Iron Company's Works at Niagara Falls. 1600 w. Am Mach—Vol. 28, No. 32. No. 71261.

Notes on Cranes—Gantries. A. D. Williams. Illustrates and describes various types. 3500 w. Am Mach—Vol. 28, No. 31. No. 71192.

Dies.

A Sectional Trimming Die. Gives plan, and side and sectional views of die, with description. 600 w. Am Mach—Vol. 28, No. 32. No. 71262.

A Set of Forging Dies. P. Sandieson. Illustrates and describes forging dies for use on a pneumatic and on a steam hammer, which serve as an example of methods used to obtain results in a modern forge. 600 w. Am Mach—Vol. 28, No. 33. No. 71377.

Eye-Bars.

Some Notes on the Development of Eye-Bar Manufacture. Joseph H. Springer, Sr. Reviews the early history of the use and manufacture of eye-bars, and traces the development and progress. 2500 w. Eng News—Aug. 17, 1905. No. 71381.

Factories.

Factory Fire Drills. H. F. J. Porter. An illustrated article briefly discussing the precautions that should be taken to insure the safety of employees in case of fire. 2000 w. Cassier's Mag—Aug., 1905. No. 71384 B.

We supply copies of these articles. See page 159.

Fans.

The Design of Centrifugal Fans. Max Buch. Gives formulæ for the design of centrifugal fans largely used in continental practice, and describes their construction. Deals only with low-pressure fans. 1800 w. Prac Engr—July 21, 1905. Serial. 1st part. No. 71153 A.

Flanged Rings.

The Flanged Mouth-piece Rings of Vulcanizers and Similar Vessels. An illustrated article dealing with the strength of the flanged ring which is riveted to the main shell of the vessel, particularly considering one mode of failure of this ring. Also the mathematical theory of the stresses in these mouth-piece rings, etc. 11500 w. Locomotive—July, 1905. No. 71132.

Foundries.

Foundry Department of the National Transit Co., Oil City, Pa. Illustrates and describes an interesting plant which manufactures in large quantities grey iron castings, steel castings, and brass and bronze castings, all of high quality. 1400 w. Foundry—Aug., 1905. No. 71336.

Foundry Practice. Dr. Richard Moldenke. Abstract from a lecture delivered at the Case School of Applied Science, Cleveland. Discusses the work of the technical man in the foundry. 3500 w. Ir Trd Rev. Aug. 17, 1905. No. 71397.

Index Plates.

Generating a Large Index Plate. A. L. de Leeuw. Illustrates and describes the method used. 3500 w. Mach, N. Y.—Aug., 1905. No. 71141 C.

Jig.

An Indexing Drill Jig. George F. Popplewell. Drawings and description of the construction. 800 w. Am. Mach—Vol. 28, No. 33. No. 71376.

Lathes.

High-Speed Lathes. Joseph Horner. Gives illustrations of lathes designed to utilize the new high-speed cutting steels, describing them and explaining their value. 7500 w. Cassier's Mag—Aug., 1905. No. 71387 B.

108-In. Lathe for Turning Turbine-Rotors. Illustrated detailed description of a lathe built for heavy work, in which great care has been taken with details of design to increase its utility. 1300 w. Engng—July 28, 1905. No. 71253 A.

Milling Machine.

Universal Milling Machine. Illustrated description of a milling machine manufactured at Providence, R. I. 1200 w. Engng—Aug. 18, 1905. No. 71633 A.

Moulding.

Sweeping a Cylindrical and Conical Drum. H. J. McCaslin. Explains the use of these drums, describing the device employed in producing them, the method of sweeping the mold, building the core, etc. Fully illustrated. 2000 w. Foundry—Aug., 1905. No. 71337.

New Works.

An English Gear-Cutting Works. I. W. Chubb. Illustrated detailed description of new shops at Lockwood, near Huddersfield, and their arrangement and equipment. 2000 w. Am Mach—Vol. 28, No. 31. No. 71191.

Planing-Machine.

Planing-Machine for Locomotive Frame Plates. Brief illustrated description of a fine planing-machine built at Leeds, Eng. 600 w. Engng—July 21, 1905. No. 71161 A.

Repairing.

Repairing a 400-Ton Hydraulic Press. Frank M. Davis. The broken head of a powerful forcing press was replaced by a steel disk held in place by a cross bar and loop bolts secured to the cylinder lugs. 1200 w. Mach, N. Y.—Aug., 1905. No. 71142 C.

Riveting.

A Hand Pressure Riveting Machine. Dr. Alfred Gradenwitz. Illustrated description of a machine constructed by F. Arnodin with the view to obtain by hand labor rivets as satisfactory as those obtained by hydraulic pressure or other mechanical means. 400 w. Sci Am—Aug. 19, 1905. No. 71389.

Rolls.

Designing Beam Rolls. Carl Holzweiler. Abstract of an article published in *Stahl und Eisen*, giving data used by the author to lay out the rolls and then to see whether or not the design is satisfactory. Ills. 1500 w. Ir Age. Aug. 17, 1905. No. 71375.

Screws.

Standard Leading Screws for Screw-Cutting Lathes. From the report of a committee appointed by the British War Department to consider the provision of standard leading screws for screw-cutting lathes. States the difficulties surrounding the problem, the action that should be taken and gives the recommendations. 4000 w. Mech Engr—Aug. 5, 1905. No. 71352 A.

The Interchangeability of Large Screws. Reviews the report of the committee appointed by the British War Department, giving verbatim the part of the report dealing with the design and construction of the leading-screw-adjusting machine, and the recommendations. Ills. 3700 w. Engng—Aug. 4, 1905. No. 71360 A.

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Shop Practice.

Toolroom and Machine Shop Practice. George R. Martin. Discusses errors due to temperature, boring in the lathe with a tool bar, keyseating gages, a crankshaft fixture, a boring tool, and a gage for ball race. Ills. 1500 w. Am Mach—Vol. 28, No. 31. No. 71193.

Stores.

Working Examples of Successful Stores Management. Walter B. Snow. A fully illustrated description of the system and methods of the B. F. Sturtevant Company, with reproductions of forms and records. 2000 w. Engineering Magazine—Sept., 1905. No. 71658 B.

Welding.

Autogenous Welding (Autogene Schweissung). Discussing the use of the oxyhydrogen and oxyacetylene blowpipes for welding, and describing the commercial production of oxygen and hydrogen for the purpose by the electrolysis of water. 2500 w. Stahl u Eisen—Aug. 1, 1905. No. 71583 D.

The Electrolytic Production of Hydrogen and Oxygen for Welding Purposes. Dr. Alfred Gradenwitz. Illustrates and describes the Schuckert apparatus which produces the oxygen and hydrogen gases by the decomposition of water. 800 w. Sci Am—Aug. 12, 1905. No. 71280.

Works.

Some French Motor Car Works. The present number gives an illustrated description of the Panhard and Levassor works at Paris, reviewing their history. 4000 w. Engr, Lond—Aug. 4, 1905. Serial. 1st part. No. 71369 A.

Works Management.

See Industrial Economy.

MATERIALS OF CONSTRUCTION.

Alloys.

Practical Alloying. J. F. Buchanan. The present number considers ancient and modern methods of metal refining. 5000 w. Foundry—Aug., 1905. Serial. 1st part. No. 71338.

Boiler Plates.

Fractures in Large Steel Boiler Plates. J. T. Milton. Read before the Inst. of Naval Archts. Describes several cases, examining the causes of fracture, reporting tests made, discussing treatment, and investigating the subject generally. 7000 w. Engng—Aug. 4, 1905. Serial. 1st part. No. 71366 A.

Brittleness.

The Influence of Brittleness of Steel upon the Effects of Shearing, Punching and Drilling in Boiler Making (Influence de la Fragilité de l'Acier sur les Effets du Cisaillement, du Poinconnage et du Brochage dans la Chaudronnerie). Ch. Frémont. Data and results of tests upon a number of plates. 1000 w. Comptes Rendus—July 31, 1905. No. 71528 D.

Flange Tests.

Tests of Cold-Rolled Flanged Pipe Connections. Luther D. Lovekin. Gives results of a series of tests made to demonstrate the practicability of copper pipes rolled into steel flanges by machinery, and the ability of machinery to place flanges on steel pipe. Ills. 2500 w. Marine Engng—Aug.,, 1905. No. 71120 C.

Iron.

Note on the Crystallization of Wrought Iron. Prof. J. O. Arnold. Plate and description of an example of crystalline structure of iron, from a wrought-iron bolt which had been broken after 30 years' use. 1000 w. Engr, Lond—Aug. 18, 1905. No. 71637 A.

The Mechanical Properties of Iron in Isolated Crystals (Les Propriétés Mécaniques du Fer en Cristaux Isolés). F. Osmond and Ch. Frémont. Tests upon crystals of iron, showing the relation of strength to crystalline axes, and of fracture to the planes of cleavage. 1200 w. Comptes Rendus—Aug. 7, 1905. No. 71530 D.

Materials.

Mechanical Engineering Materials: Their Properties and Treatment in Construction. Edward C. R. Marks. The present article considers cast iron, giving notes, analyses, etc., from named sources. 2500 w. Prac Engr—Aug. 4, 1905. Serial. 1st part. No. 71349 A.

Pulleys.

The Bursting Strength of Wooden Pulleys. C. H. Benjamin. An illustrated article giving results of a series of experiments carried on in the laboratories of the Case School, Cleveland, Ohio. 1800 w. Mach, N. Y.—Aug., 1905. No. 71140 C.

Rivets.

Modifications in the Quality of the Metal of Rivets by the Operation of Riveting (Modification de la Qualité du Métal des Rivets par l'Opération du Rivetage). M. Charpy. Showing that the rivets may be improved or injured according to the temperature conditions. 800 w. Comptes Rendus—July 31, 1905. No. 71529 D.

Sands.

Core Sands. J. S. Robeson. Read before the A. F. A. Convention. Gives photo-micrographs, showing the variations in the sands used in core making, and that failures are often due to the sand used rather than to the binder. States the requirements for a good binder. 2200 w. Foundry—Aug., 1905. No. 71339.

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Steel.

A Preliminary Report on the Effect of Combined Stresses on the Elastic Properties of Steel. Edward L. Hancock. Presented before the Am. Soc. of Test. Mat. Gives results of a series of tests on solid steel rounds in torsion while under tension, explaining methods used. Ills. 1800 w. Eng. News—Aug. 24, 1904. No. 71482.

High-Speed Steel in the Factory. O M. Becker and Walter Brown. The first of a series dealing with the problems included in the introduction of rapid-cutting steels, the whole forming a complete review of the subject. 3000 w. Engineering Magazine—Sept., 1905. No. 71660 B.

High-Speed Tool Steels (Aciers Outils à Coupe Rapide). L. Guillet. A review of the development of high-speed steels, with chemical analyses, micro-photographs, and tables of results of tests. 5000 w. 1 plate. Mem Soc Ing Civ de France—June, 1905. No. 71597 G.

Notes upon the Properties, Tests and Classification of Ternary Steels (Comparaisons des Propriétés, Essais, et Classification des Aciers Ternaires). Léon Guillet. A brief note upon the steels consisting of iron, carbon, and a third constituent, such as nickel, manganese, etc. 800 w. Comptes Rendus—July 10, 1905. No. 71524 D.

Testing Machine.

A Large Hydraulic Testing Machine for Uniform Loads. Robert A. Cummings. From a paper recently read before the Am. Soc. of Test. Materials. Illustrations with descriptions. 1100 w. Eng. Rec—Aug. 12, 1905. No. 71335.

MEASUREMENT.

Adding Machine.

The Use and Construction of the Adding Machine. Fred W. McArdle. Explains various types and their uses, the principles and the operation. 2400 w. Am Mach—Vol. 28, No. 32. No. 71263.

Anemometers.

Recording Devices for Measuring Velocity and Volume (Registrierende Geschwindigkeits und Volumenmessung). E. Stach. Illustrating and describing anemometers for obtaining records of the flow of air in mine workings for successive weeks. 3500 w. Glückauf—Aug. 12, 1905. No. 71549 D.

Calorimeter.

Measuring the Mechanical Equivalent of Heat. Illustrates and describes the invention of Prof. H. L. Callendar and its working. 800 w. Sci Am—Aug. 19, 1905. No. 71391.

Flue Gases.

Improved Methods of Flue-Gas Analysis (Neuanordrung einer Vorrichtung zur Rauchgasuntersuchung). M. Moller. Describing improvements in apparatus of the Orsat type for the analysis of the waste gases discharged by boiler and other furnaces. 1500 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—July 8, 1905. No. 71550 D.

Friction.

Investigations into Journal Friction according to the Method of Dettmar (Versuche über Lagerreibung nach dem Verfahren von Dettmar). H. Heimann. With description of apparatus and diagrams showing the influence of temperature, pressure and lubricants. Two articles. 6000 w. Zeitschr d Ver Deutscher Ing—July 15, 29, 1905. No. 71505 each D.

Sliding Friction (Sur le Frottement de Glissement). M. de Sparre. An examination of Painlevé's review of the theory of Coulomb, showing that the indeterminate nature of the result is only apparent. 1200 w. Comptes Rendus—July 31, 1905. No. 71526 D.

Loads.

Calculation of Loads on the Rollers of a Large Locomotive Crane. A. L. Westcott. Gives sketch showing a portion of the plan of the roller track of a 40-ton locomotive crane, and explains method of calculating the loads. 900 w. Am Mach—Vol. 28, No. 34. No. 71494.

POWER AND TRANSMISSION.

Air Discharge.

An Experimental Determination of the Coefficient of Discharge of Air. Sanford A. Moss. Gives methods used in determining the co-efficient of discharge through an orifice under actual conditions of use, with results. 4800 w. Am Mach—Vol. 28, No. 32. No. 71266.

Belt Driving.

Determining the Position of Idler Pulley for the General Care of Belt Transmission. R. N. Macalister. Explains the method of finding the position of idler pulleys in belt drives for transmitting power between shafts whose axes are not parallel. 900 w. Am Mach—Vol. 28, No. 34. No. 71493.

Bull Wheels.

Bull Wheels and Tangent Arms. W. Osborne. Explains why the arms in bull wheels are put on at a tangent to the shaft instead of radially. Ills. 700 w. Am Mach—Vol. 28, No. 32. No. 71264.

Compressed Air.

Heat of Compression in Air Cylinders and the Relation to Explosion. E. Hill.

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Discusses the effects of leaks in cylinders on temperatures. 1200 w. Mines & Min —Aug., 1905. No. 71203 C.

Thermal Researches on Air Compressors (Thermische Untersuchung an Kompressoren). Fritz L. Richter. Data and results of an exhaustive series of experiments to ascertain the temperature at various stages of the process in a Riedler-Stumpf air compressor. Three articles, 7500 w. Zeitschr d Ver Deutscher Ing—July 8, 22, Aug. 5, 1905. No. 71500 each D.

Westinghouse Compound Pumps. F. H. Parke. Illustrates and describes a new design consisting of three cylinders placed vertically in tandem, explaining its working. 1700 w. Am Engr & R R Jour—Aug., 1905. No. 71139 C.

Conveyors.

Aerial Tramways in the Tug River Coal Fields. Henry Mace Payne. Illustrated description of two plants built to carry the coal mined on Kentucky side of Tug River to the railroad on the West Virginia side. 700 w. Sci Am—Aug. 19, 1905. No. 71390.

An Electrically Driven Conveyor (Eine Elektrisch Betriebene Fahrbare Kabelbahn). H. Landmann. Illustrating and describing a traveling crane and cable conveyor for handling coal. 2000 w. Zeitschr d Ver Deutscher Ing—July 22, 1905. No. 71507 D.

Developments in Machinery for Transmitting Materials. Gilbert Little. An illustrated article describing appliances for the mechanical transit of materials. 2000 w. Jour Gas Lgt—Aug. 1, 1905. No. 71342 A.

Elevators.

Electric Elevators (Elektrische Aufzuge). O. Pollok. Brief illustrated description of the electric elevator recently installed in the library of the University of Giessen. 1000 w. Zeischer d Ver Deutscher Ing—July 8, 1905. No. 71502 D.

Gearing.

Gear Designs and Manufacture. Remarks on gears as a device for the transmission of power, giving a demonstration of Reuleaux's geometrical method for "laying off" the epicycloidal teeth of gears, and discussing involute teeth, spokes or arms, hubs and the manufacture. Ills. 3000 w. Can Engr—Aug., 1905. Serial. 1st part. No. 71194.

Spur Gearing. N. A. Carle. Gives diagrams for the rapid calculation of gear variables based on the empirical formula used by Jones and Laughlin for cast-iron gears, with explanation. 700 w. Power —Sept., 1905. No. 71643 C.

Power Plants.

Mechanical Plant of the New York Hippodrome. Illustrates and describes a remarkable plant for producing theatrical effects for amusement purposes. Both electrical and mechanical means are utilized. Also for lighting, heating and artificial cooling. 5000 w. Eng Rec—Aug. 26, 1905. No. 71617.

Modern Power Plant Design and Economics. Franz Koester. The second article discusses the steam generating portion of the plant, including coal and ash handling, water supply, mechanical draft, etc. 5000 w. Engineering Magazine—Sept., 1905. No. 71655 B.

The Power Plant of the United Shoe Machinery Co. Howard S. Knowlton. Illustrated detailed description of the power plant of these shops at Beverly, Mass. 4300 w. Eng Rec—Aug. 19, 1905. No. 71438.

STEAM ENGINEERING.

Boiler Design.

Legal Complications Over Boiler Design. Reprint of a decision rendered in the Supreme Court of Errors of Connecticut which shows in an interesting way the relations between engineer and supply man. 2000 w. Eng Rec—Aug. 5, 1905. No. 71238.

Boilers.

Recent Installations of Niclausse Boilers (Neuere Kesselanlagen mit Niclausse Kesseln). Carl Züblin. A general review of recent naval vessels equipped with Niclausse water-tube boilers, with details of installations. Serial. Part I. 1800 w. Schiffbau—July 12, 1905. No. 71591 D.

Water Tube Locomotive Boiler (Chaudière de Locomotive à Tubes d'Eau). F. Barbier. Illustrated description of the Robert water-tube boiler as fitted to engines of the Algerian railways. 1800 w. 1 plate. Génie Civil—July 29, 1905. No. 71518 D.

Condensation.

Condensing Plant Design. Illustrates and describes the design of a surface plant. 2500 w. Prac Engr—Aug. 11, 1905. No. 71451 A.

Counterbalancing.

Counterbalancing an Oscillating Engine. Explains the peculiarities in the design of the Case engine, and the experimental work done in investigating the subject of counterbalancing. Ills. 1200 w. Mach, N. Y.—Aug., 1905. No. 71143 C.

Draught.

Artificial Draught for Boiler Plants. F. H. Davies. Discusses briefly the systems

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of mechanical draught and their operation. 2000 w. Elec Engr, Lond—Aug. 11, 1905. No. 71454 A.

Engines.

Design and Construction of Steam Engines. Reviews the development briefly, and the improvements of the last 150 years in the present number. 1800 w. Mech Engr—Aug. 19, 1905. Serial. 1st part. No. 71625 A.

Double Tandem Reversing Engine with Improved Valve Gear (Zwillings Tandem Reversiermachine mit Neuer Steuerung). W. Schnell. A heavy rolling mill engine with piston valves and Allan straight link, the link being reversed by hydraulic power. 800 w. 1 plate. Stahl u Eisen—Aug. 1, 1905. No. 71582 D.

18,000 Horse Power Rolling Mill Engines. Two-page plate, illustrations and description of a vertical rolling-mill engine recently constructed, intended to drive the heaviest class of rolls, and to be very economical in steam. 900 w. Engng—Aug. 18, 1905. No. 71635 A.

Modern British High-Speed Steam Engines. Leo H. Jackson. Gives description of the standing and running parts of a typical engine, considering deviations made by different makers. 4500 w. Cassier's Mag—Aug., 1905. Serial. 1st part. No. 71383 B.

Links in the History of the Steam Engine. Gives particulars of some old prints recently found at the British Museum. Illustrations, with reprint of "A Description of the Engine for Raising Water by Fire," with remarks. 4000 w. Engr, Lond—Aug. 11, 1905. No. 71466 A.

600-Horse Power Carels Compound-Condensing Engine. Illustrated description of an engine shown at the Liége Exhibition. 1500 w. Engng—Aug. 11, 1905. No. 71463 A.

The Atlas Four-Valve Engine. Illustrated description of a new type of four-valve engine of medium size. 1500 w. Engr, U S A—Aug. 15, 1905. No. 71422 C. 71422 C.

The Boujour Engine. Illustrates and describes a 75-horse power condensing engine shown at the Liége Exhibition. 2000 w. Engr, Lond—July 28, 1905. No. 71257 A.

The Engines of the Interborough Station. Illustrated detailed description of the horizontal vertical twin compound Allis-Chalmers engines in the N. Y. Subway power house. 2500 w. Power—Sept., 1905. No. 71641 C.

The "Hoyois" Steam Engine. Illustrates and describes a single-cylinder engine exhibited at the Liége Exhibition. 500 w. Engng—July 21, 1905. No. 71162 A.

Feed Water.

Feed-Water Heaters. Ernest R. Briggs. Discusses the commercial economy effected by the feed-water heater, and considers the regenerative system. Ills. 3400 w. Engr, Lond—July 28, 1905. No. 71256 A.

Governor.

The Nordberg Static Governor. Illustrated description of a governor for pumping engines and air compressors which introduces the new principle of controlling the speed through a wide range by a centrifugal governor. 900 w. Am Mach—Vol. 28, No. 34. No. 71491.

Heat Engines.

Substitutes for Steam. Compares water and bisulphid of carbon, following them through their respective cycles and showing how the amounts of heat supplied compare with the results obtained. Ills. 3500 w. Power—Sept., 1905. No. 71642 C.

Priming.

The Measurement of the Water Entraining Steam (Mesure de la Quantité d'Eau Entrainée par la Vapeur des Générateurs). M. Emanaud. Describing especially the Brocq apparatus and also the method of dissolving salt in the water. 2500 w. Génie Civil—Aug. 12, 1905. No. 71522 D.

Pumping Engine.

See Mechanical Engineering. Hydraulics.

Receivers.

Something About Receivers. W. H. Wakeman. Considers points in piping receivers of steam plants. Ills. 1200 w. Power—Sept., 1905. No. 71644 C.

Reducing Motions.

A Differential Reducing Motion. D. L. Gallup. Illustrated description of an accurate device for obtaining correct indicator diagrams. 300 w. Engr, U. S. A.—Aug. 1, 1905. No. 71232 C.

Smoke Prevention.

Smokeless Combustion and Economy of Fuel. William Mayner. Illustrates and describes the mechanical stoker and smoke consumer invented by Charles Wegener, a German engineer. 1800 w. Sci Am Sup—Aug. 26, 1905. No. 71488.

See Civil Engineering, Municipal.

Steam Pumps.

Steam Pumps and Their Failures. M. Powis Bale. Considers some of the principal causes of pumps failing. 2000 w. Prac Engr—Aug. 4, 1905. No. 71351 A.

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Stuffing Box.

A Double Stuffing Box (Doppellagerabdichtung). Hr. Toussaint. Illustrating a form of stuffing box especially adapted for maintaining a tight joint about revolving shafts, as propeller shafts, or the spindles of steam turbines or centrifugal pumps. 1200 w. Zeitschr d Ver Deutscher Ing—Aug. 12, 1905. No. 71514 D.

Superheating.

Tests of a Superheating System with Utilization of Waste Gases (Untersuchung einer Dampfkraftanlage mit Zweifacher Ueberhitzung durch Abgase). E. Josse. Data and results of tests upon the Wolf semi-portable tandem compound engine, using superheated steam. Two articles, 5000 w. Zeitschr d Ver Deutscher Ing. July 15, 22, 1905. No. 71504 each D.

Tests.

One Hundred Steam Engine Tests (Ein Hundert Dampfverbrauchsversuche). J. Krumper. A tabulated discussion of economy tests upon a large number of steam engines of various types, built by the United Augsburg and Nürnberg Works. Serial. Part I. 5000 w. Zeitschr d Ver Deutscher Ing—Aug. 12, 1905. No. 71511 D.

Tube Cleaners.

Misuse of Boiler Tube Cleaners. A. S. Atkinson. Discusses some of the causes of trouble and the ruin wrought by incompetent workmen, and the question of the kind of power used to operate the cleaners. 1800 w. Boiler Maker—Aug., 1905. No. 71236.

Valve Gears.

The Selection of Eccentrics for Double Valve Gears (Die Wahl der Exzenter bei Doppelschiebersteuerungen). W. Pickersgill. With valve diagrams showing the influence of variations in eccentricity upon valve action in slide-valve engines. 2000 w. Zeitschr d Ver Deutscher Ing—July 8, 1905. No. 71501 D.

Valves.

Emergency Valves. W. H. Wakeman. Illustrated descriptions of emergency valves for use with high pressure steam, explaining their applications. 1000 w. Elec, N. Y.—Aug. 2, 1905. Serial. 1st part. No. 71144.

Low Pressure Slide Valve with Triple Openings for Admission and Exhaust (Niederdruckschieber mit Dreifacher Eröffnung für Einlass und Auslass und mit Ueberströmung). M. Hochwald. The valve is a combination of the Penn double-ported valve and the Allen valve with auxiliary passage, giving quick and large opening with small travel. 1200 w. Zeitschr d Ver Deutscher Ing—Aug. 12, 1905. No. 71513 D.

Steam Turbines.

Determinations of the Efficiency and Steam Consumption of Steam Turbines (Beiträge zur Bestimmung des Wirkungsgrades und Dampfverbrauches von Dampfturbinen). H. Anders. With numerous tabulated results of tests of Parsons turbines driving electrical generators. 6000 w. Glückauf—July 15, 1905. No. 71541 D.

The Steam Turbine as Applied to Electrical Engineering. Charles A. Parsons, G. Gerald Stoney and C. P. Martin. Read before the Inst. of Elec. Engrs. Gives the history of the development of the steam turbine as applied to electrical engineering, explaining details, and giving results obtained. 4000 w. Sci Am Sup—Aug. 12, 1905. No. 71284.

MISCELLANY.

Earthenware.

Machinery made of Earthenware (Maschinen aus Steinzeug). Georg Lindner. Describing plunger and centrifugal pumps, blowers, and other machines made of glazed earthenware to resist the action of acids and other corrosive fluids. 5000 w. Zeitscher d Ver Deutscher Ing—Aug. 12, 1905. No. 71510 D.

MINING AND METALLURGY

COAL AND COKE.

British Columbia.

The Nicola-Coldwater Coal Beds. Horace F. Evans. A description of the geology of this valley in British Columbia. 2500 w. Min Wld—Aug. 19, 1905. No. 71416.

By-Products.

By-Product Coke Ovens in Westphalia (Zur Frage der Nebenproduktgewinnung beim Kokereibetriebe in Westfalen). W. Fritz. Describing the construction of the Otto coke ovens in the Westphalia district, and the recovery of sulphate of ammonia as a by-product. Serial. Part I. 1500 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Aug. 5, 1905. No. 71552 D.

Cannel Coal.

Cannel Coal in the United States. George H. Ashley. Considers the causes

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of failures of cannel coal, the importance of investigating the appearance, analysis, thickness, extent of the beds, and discusses the uses for which it is adapted. 3800 w. Min Wld—July 29, 1905. Serial. 1st part. No. 71122.

Coal District.

Map of the Zwickau Coal District (Uebersichts Karte des Zwickauer Steinkohlenreviers). J. Treptow. General description of the district, with map showing the location of the collieries. 1800 w. 1 plate. Glückauf—Aug. 5, 1905. No. 71548 D.

Coke.

The Beginnings of Coke Manufacture (Die Anfange der Koksfabrikation). Oscar Simmersbach. An historical review, with sketches of early coke ovens used in Germany and England. 4000 w. Glückauf—July 8, 1905. No. 71540 D.

Maryland.

Ocean No. 7, or "Klondike" Mine of the Consolidation Coal Company in the Georges Creek Region, Maryland. J. J. Rutledge. Illustrated description of the mine and its workings. 4500 w. Mines & Min—Aug., 1905. No. 71201 C.

Newfoundland.

Newfoundland Coal. Information concerning the valuable deposits. 1400 w. Col Guard—Aug. 11, 1905. No. 71459 A.

New Mexico.

New Coal Developments in Northern New Mexico. Emerson W. Judd. Illustrates and describes the property and the arrangements to increase the output. 1200 w. Eng & Min Jour—Aug. 19, 1905. No. 71430.

Peat.

Peat in Florida. J. M. Cheney. Illustrates and describes a plant for the manufacture of peat briquets, giving information in regard to their use, cost, etc. 1500 w. Engr, U. S. A.—Aug. 15, 1905. No. 71421 C.

Production.

The Production of Coal in 1904. Edward W. Parker. From the Mineral Resources of the United States. Gives statistics and a review of the conditions. 4400 w. Min Wld—Aug. 19, 1905. No. 71415.

Queensland.

Queensland Anthracite Coal. R. J. Cottell. Information concerning this industry in Central Queensland, giving an analysis of the coal, and the results obtained with it. 1800 w. Aust Min Stand—July 12, 1905. No. 71495 B.

Queensland Coal Mines. Reports of mine inspectors in regard to the trade, production, coalfields, etc. Plate. Ills. 5000 w. Queens Gov Min Jour—June 15, 1905. No. 71173 B.

Silesia.

Present Knowledge of the Hard Coal District of Upper Silesia (Der Heutige Stand unserer Kenntnisse über das Oberschlesische Steinkohlengebirge). H. Geisenheimer. A detailed account of important coal deposits lying between the Prussian, Russian and Austrian frontiers, with map and sections. 5000 w. 2 plates. Glückauf—July 22, 1905. No. 71543 D.

Wyoming.

The Coal of the Black Hills, Wyoming. N. H. Darton. Describes the deposits and reports the extent to which they have been worked. 2800 w. Min Wld—Aug. 5, 1905. No. 71197.

COPPER.

Electro-Metallurgy.

See Electrical Engineering, Electrochemistry.

Trans-Caucasus.

The Copper Industry of the Trans-Caucasus. Gives the more important deposits so far investigated. The information is from a recent Russian report. 700 w. Engng—Aug. 4, 1905. No. 71362 A.

Treatment.

New Methods in the Metallurgical Treatment of Copper Ores. N. S. Keith. Describes a method for the utilization of low-grade copper ores. 3500 w. Jour Fr Inst—Aug., 1905. No. 71295 D.

The Treatment of Copper Rock at the Quincy Mills, Hubbell, Mich. C. K. Hitchcock, Jr. Describes the rock, and the method of treatment used, which aims to reduce, as far as practicable, the loss in the tailings. Plate. 2500 w. Sch of Mines Qr—July, 1905. No. 71297 D.

GOLD AND SILVER.

Alaska.

Gravel and Placer Mining in Alaska. Custer Wells Purington. Explains the methods of mining made necessary by the unusual conditions, giving information in regard to the cost. Map. 4000 w. Min Wld—July 29, 1905. No. 71123.

Amalgamation.

Amalgamating Tables. Algernon Del Mar. Gives sketches of three styles of tables, discussing the important essentials. 900 w. Min & Sci Pr—Aug. 5, 1905. No. 71322.

A New Device for Amalgamating Gold in Sands and Pulps. Illustrates and describes a device invented by Patrick McEntee for treating gold-bearing sands, stamp mill pulp, and other material. 1200 w. Min Rept—Aug. 24, 1905. No. 71607.

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California.

The Ancient Channel of Gibsonville, Cal. Samuel C. Wiel. Describes these channels and the old methods of mining, the character of the gravels, and the general conditions. Ills. 1800 w. Min & Sci Pr—July 29, 1905. No. 71195.

Clean-Up.

The Use of Bisulphate of Sodium in the Clean-Up. Jas. E. Thomas and Gerard W. Williams. Reports a series of experiments and the results. 2500 w. Jour Chem, Met & Min Soc of S Africa —June, 1905. No. 71345 E.

Comstock.

The Comstock Lode. Don Maguire. Description and history of the discovery and development of one of the richest ore deposits ever mined. Ill. 6000 w. Mines & Min—Aug., 1905. No. 71200 C.

Cupellation.

Cupellation and Parting. Herbert R. Edmonds. Considers the shape of cupels and the material, referring to paper by Dr. Kirke Rose. 1000 w. Eng & Min Jour—Aug. 12, 1905. No. 71305.

Cyanide.

Gold Extraction by Cyanide: a Retrospect. John S. MacArthur. States the circumstances which led to the invention of the cyanide process. 1800 w. Eng & Min Jour—Aug. 12, 1905. No. 71308.

Precious Metals Recovered by Cyanide Processes. Charles E. Munroe. From the *Census Bulletin*. Reviews the history of the cyanide process, giving information from various sources showing the varieties of methods. 4000 w. Sci Am Sup—Aug. 5, 1905. Serial. 1st part. No. 71190.

Dredging.

Gold Dredging in California. A. G. Hillen. An illustrated article giving information in regard to the extent of this method of working, the cost, &c. Map. 2500 w. Min Wld—Aug. 5, 1905. No. 71196.

Gold Dredging in California. Information from the Bul. of the State Min. Bureau of Cal., giving the history of dredge mining in the state, the area of dredge gravel, &c., in the present number. Ills. 2800 w. Min & Sci Pr—Aug. 19, 1905. Serial. 1st part. No. 71610.

Free Gold.

Free Gold in Veins. Arthur Lakes. Gives instances which in the writer's opinion prove that gold may exist free, in free solutions, in veins or other rocks and be deposited in a crystalline, free or native state. 1200 w. Min Wld—July 29, 1905. No. 71124.

Hydraulic Mining.

Hydraulic Mining with Centrifugal Pumps. Enos Brown. Illustrates and describes a successful plant installed at Grant's Pass, Oregon, where there are acres of rich placers which have never been extensively worked. 1100 w. Sci Am—Aug. 19, 1905. No. 71388.

India.

Milling in India. Robert F. J. Weeks. A brief account of metallurgical operations (milling) at the Champion Reef Gold Mining Co. of India, Ltd. 2400 w. Mines & Min—Aug., 1905. No. 71204 C.

New South Wales.

Mount Boppy (N. S. W.). J. B. Jaquet. The Chief Inspector of Mines report on this goldfield, describing its geology and reporting concerning the development. Ills. 1800 w. Aust Min Stand—July 12, 1905. No. 71496 B.

Placers.

Placer Mining in Alaska. C. W. Purington. Abstract from the Bulletin of the U. S. Geol. Survey, describing the methods of mining. Ills. 1800 w. Min & Sci Pr—Aug. 12, 1905. Serial. 1st part. No. 71425.

Placers.

Placer Mining in Siberia. Abstract translation from *L'Industrie Aurifere*. M. D. Levat. Describes some of the difficulties, the methods of work, and the prospecting. 1500 w. Min Wld—Aug. 26, 1905. No. 71604.

Queensland.

Black Ridge, Clermont. Lionel C. Ball. Preliminary report of the geological survey, giving location, geology, deposits and general information of the auriferous ground. Ills. 10000 w. Queens Gov Min Jour—June 15, 1905. Serial. 1st part. No. 71172 B.

Tailings.

Saving Coarse Gold from Tailings After Direct Cyaniding by Means of an Agitator. Paul J. Johnson. Detailed description of the writer's method of using an agitator and the results. Ill. 1200 w. Min Rept—July 27, 1905. No. 71113.

Some Suggestions on the Cyaniding of the Tailings. Prof. A. Prister. Describes a proposed working method which the writer considers worth a serious discussion. 2000 w. Jour Chem, Met, & Min Soc of S Africa—June, 1905. No. 71346 E.

Transvaal.

The Transvaal Gold Mines. Theodore F. Van Wagenen. Begins a review of this industry in the Transvaal. 1700 w. Min & Sci Pr—Aug. 19, 1905. Serial. 1st part. No. 71608.

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Water Recovery.

An Experience in Water Recovery. George S. Binckley. Describes the method of recovery at Congress, Arizona, giving illustrations. Also the design of a recovery plant where there was a very limited flow of water, and the working of the system. 3000 w. Min & Sci Pr—Aug. 19, 1905. No. 71609.

Yukon.

The Yukon Territory. An address delivered by Dr. R. W. Raymond at the farewell banquet given to the visiting party of the Am. Inst. of Min. Engrs. at Dawson, Y. T. 1800 w. Eng & Min Jour—Aug. 12, 1905. No. 71308.

IRON AND STEEL.

Blast Furnaces.

Blast Furnace Gas Blowers. Dr. Alfred Gradenwitz. Illustrates and briefly describes examples of gas-driven blowers made in Germany. 600 w. Ir Trd Rev—Aug. 17, 1905. No. 71396.

Blow Holes.

A Study of the Causes of Blow Holes in a Steel Block (Untersuchung über den Ursprung eines Blasenraumes in einem Flusseisenblocke). Dr. H. Wedding. With micro-photographs showing the internal structure of the fractured metal, and data of chemical and physical examinations. 2500 w. Stahl u Eisen—July 15, 1905. No. 71580 D.

Castings.

See Mechanical Engineering, Machine Works and Foundries.

Electric Smelting.

See Electrical Engineering, Electro-Chemistry.

Furnaces.

Britain's Earliest Iron Furnaces and Moulding Floors. Thomas May. An illustrated article describing remains of smelting, refining, moulding and other furnaces investigated during recent excavations, and showing the Roman methods of iron manufacture. 7500 w. Ir & Coal Trds Rev—Aug. 11, 1905. No. 71468 A.

Gate Valve.

A Large Gate Valve of New Type for Low Pressures. John J. Smith. Illustrates and describes valves designed for blast-furnace work. 1500 w. Am Mach—Vol. 28, No. 34. No. 71492.

Iron.

See Mechanical Engineering, Materials.

Live Rolls.

Notes on Live Conveying Rolls for Structural-Shape Rolling Mills (Einiges über Warmlager und Adjustagen Schwerer Profileisenstrassen). Bruno Quast. Discussing methods for increasing the carrying capacity of the conveying rolls for rail and similar mills. 2000 w. Stahl u Eisen—Aug. 15, 1905. No. 71586 D.

Luxembourg.

The Development of the Iron Industry of Luxembourg Since 1879 (Der Werdegang der Eisenindustrie Luxemburgs seit 1879). Gustav Loose. A review of the iron industry of Luxembourg and its commercial relations to the markets of France and Germany. 3500 w. Stahl u Eisen—July 15, 1905. No. 71579 D.

Oil Furnaces.

Care, Use and Design of Oil Furnaces. Stephen Uren. Discusses questions of the economy of oil as compared with coal, the effect on the material, and the latest improvements in furnace doors, fire brick, burners, etc. Ills. 2300 w. Pro Pacific C Ry Club—July 15, 1905. No. 71291 C.

Open-Hearth.

The Bertrand-Thiel Process. E. von Moltitz. A detailed description of this process, giving results and stating its advantages. 5000 w. Ir Age—Aug. 10, 1905. No. 71245.

Piping.

A Process for the Prevention of Piping in Large Steel Ingots (Verfahren zur Verhütung der Lunkerbildung in Schweren Rohstahlblocken). F. O. Beikirch. Describing the use of a sinking head which is afterwards cut off, removing the piped portion. 1800 w. Stahl u Eisen—Aug. 1, 1905. No. 71581 D.

Methods for the Prevention of Piping in Steel Blocks (Die Verfahren zur Verhütung der Lunkerbildung in Stahlblocken). R. M. Daelen. Describing fluid-compression methods, also methods of heating the molds, and the author's continuous process. 1800 w. Stahl u Eisen—Aug. 15, 1905. No. 71585 D.

Statistics.

The Iron Industry in the Year 1904 (Das Eisenhüttenwesen im Jahre 1904). Dr. B. Neumann. A review of the output of the principal iron-producing countries of the world, discussing the conditions from a German point of view. 7500 w. Glückauf—July 29, 1905. No. 71546 D.

Steel.

See Mechanical Engineering, Materials.

Sulphur.

The Presence of Coke Sulphur in the Blast Furnace (Das Verhalten des Koksschwefels im Hochofen). Oscar Simmersbach. An examination of extent to which sulphur may be brought into the blast furnace with the fuel; with tabulated results of analyses. 2000 w. Glückauf—July 15, 1905. No. 71542 D.

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Texas.

The Iron Industry of Texas, Present and Prospective. Edwin C. Eckel. Gives information concerning the commercial and engineering phases of the Texas iron industry. 3000 w. Ir Age—Aug. 24, 1905. No. 71474.

Titanium.

Influence of Titanium on Pig Iron and Steel. P. Delville. Read before the Min. & Met. Cong. at Liège. Gives information concerning the smelting of titaniferous ores, and the little known of the effect of titanium on iron and steel. 1200 w. Mech Engr—Aug 5, 1905. No. 71353 A.

MINING.

Deep Leads.

Charlotte Plains Deep Leads. E. J. Dunn. Describes deep alluvial mining, showing gold wash deposits. 1200 w. Aust Min Stand—July 5, 1905. No. 71247 B.

Diamond Drills.

The Diamond Drill in Missouri. R. D. O. Johnson. Describes the method of drilling in southeastern Missouri, and the great deposits of lead ore discovered and worked. 2000 w. Eng & Min Jour—Aug. 12, 1905. No. 71304.

Drainage.

The Sumps of the Lower Workings of the Barza Gold Mine near Brad in the Siebenbürgen District (Das Sumpfen der unter Wasser Tiefbau der Goldgrube Barza bei Brad in Siebenbürgen). H. Wendeborn. Describing the use of electrically-driven centrifugal pumps for shaft sinking in water bearing strata. 3000 w. Glückauf—July 22, 1905. No. 71544 D.

Dust.

Apparatus for Laying Dust in Coal-Mines. J. Cresswell-Roscamp. Abstract of a paper in Trans. Inst. of Min. Engrs., 1905. Illustrates and describes an improved watering car, and the treatment of coal-dust. 900 w. Eng & Min Jour—Aug. 26, 1905. No. 71601.

Electric Power.

Application of Electricity to Mines. A. C. Anderson. Abstract of a paper read before the British Inst. of Elec. Engrs. Considers the choice of a system, the voltage, distribution, motors, &c., and the applications to pumping, winding and haulage, coal-cutters, drilling, &c. 4800 w. Elec Rev, N Y—Aug. 19, 1905. No. 71433.

Explosives Testing.

The Testing of Explosives for Coal Mines. Illustrated description of the British Home Office testing station at Woolwich, and of stations on the Continent, with accounts of methods. Also editorial. 5500 w. Ir & Coal Trds Rev—Aug. 18, 1905. No. 71653 A.

Faults.

Fault Phenomena. A. Lakes. Illustrated description of examples of Colorado faults both old and recent, with a few practical suggestions for miners. 800 w. Min Rept—Aug. 17, 1905. No. 71424.

Fire Damp.

Protection Against Fire Damp. Describes the instrument called a methanometer, recently installed in a large colliery in Pennsylvania, and its successful working. 1400 w. Sci Am—Aug. 5, 1905. No. 71183.

Hoisting.

Hoisting Practice in the Pennsylvania Anthracite Region. R. V. Norris. With numerous illustrations of winding engines, cages, head works and details of the best modern practice of the Pennsylvania anthracite district. 3500 w. Engineering Magazine—September, 1905. No. 71659 B.

Prevention of Hoisting Accidents. A. Selwyn-Brown. Discusses the need of daily inspection of hoisting ropes, the wear, strains, and devices for diminishing strains, giving advice for the care of such ropes. Ills. 1300 w. Eng & Min Jour—Aug. 26, 1905. No. 71602.

Hoisting Ropes.

Dangerous Conditions as to Length and Number of Broken Wires in Mine Hoisting Ropes (Unsichere Drahtlänge, Gefährdete Seillänge und Zulässige Anzahl der Drahtbrüche bei für Mannsfahrten noch Verwendbaren Seilen). Hermann Kroen. Discussing principles governing the inspection of hoisting cables. 3000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Aug. 12, 1905. No. 71553 D.

Hydraulic Mining.

Hydraulic Mining Conditions in the Atlin District of British Columbia. Extract from the report of the Provincial Mineralogist. Describes the present conditions, the progress, and the character of the deposits. 1500 w. Min Rept—July 27, 1905. No. 71114.

Jig.

The Hancock Jig at Penn Wyoming Co.'s Mill. R. B. Lamb. Illustration, with brief description of a very successful machine installed at Encampment, Wyoming. 1000 w. Min & Sci Pr—Aug. 12, 1905. No. 71426.

Nova Scotia.

Metalliferous Mining in Nova Scotia as Compared with Mining in Other Countries. J. Owen James. A discussion of the mining laws, mining prospects, opera-

tions, &c. Ills. 6500 w. Ind Adv—Aug., 1905. No. 71448.

Ore Deposits.

Igneous Rocks in Ore Deposition. A. Lakes. Discusses some peculiarities of ore deposition, showing that all igneous rocks are not necessarily ore generators. 1500 w. Eng & Min Jour—Aug. 5, 1905. No. 71229.

Ore Treatment.

Mixed Sulphide Ore Treatment. W. R. Ingalls. From *The Mineral Industry*, Vol. XIII. Remarks on the treatment of these ores in the Joplin district, at Creede, Colo., and in Wisconsin and other places. 1500 w. Eng & Min Jour—Aug. 19, 1905. No. 71427.

Powder Thawing.

An Underground Magazine and an Electric Powder Thawer. William Kelly. Abstract of a paper in Pro. of the L. Superior Min. Inst. Gives an illustrated description of a central underground magazine, and an electric powder thawer. 1200 w. Eng & Min Jour—Aug. 19, 1905. No. 71429.

Roasting.

Air in Roasting. William E. Greenawalt. Gives results of tests made to determine the effects of time and air on roasting and extraction, with remarks. 1000 w. Eng & Min Jour—Aug. 19, 1905. No. 71428.

Latest Achievement in Roasting Furnaces for Quicksilver and Other Ores. Illustrates and describes the Dennis roasting furnace, giving information concerning it, and discussing its valuable features. 1500 w. Min Rept—Aug. 17, 1905. No. 71423.

Safety Lamp.

Tests of the Wolf Acetylene Safety Lamp (Versuche mit der Wolfschen Azetylen Sicherheitslampe). H. Beyling. The lamp contains a charge of carbide to which water is gradually fed; safety being attained by enclosing the flame in glass and wire gauze. 4000 w. Glückauf —July 8, 1905. No. 71539 D.

Shafts.

Misplacement of Mining Shafts and Adits. Stanley Hunter. Abstract of paper in Trans. Aust. Inst. Min. Eng. Vol. X. Gives typical examples showing waste due to mistakes in methods. Ills. 1600 w. Eng & Min Jour—Aug. 12, 1905. No. 71306.

Smelting.

The Smelter-Fume Problem. A. W. Warwick. Remarks on changes due to the consolidation of the smelting plants under one management, particularly discussing the damage from smelter-fumes, showing that it is not nearly as great as alleged, and not easy to solve. Ills. 3300 w. Min Mag—Aug., 1905. No. 71288 C.

Timbering.

Timbering and Arching in Mines. Idris Thomas. Read before the South Wales Inst. of Engrs. An illustrated description of the methods adopted in every-day labor in South Wales coal mines, where some of the finest examples of timbering may be found. 5500 w. Ir & Coal Trds Rev—July 21, 1905. No. 71171 A.

Ventilation.

A Successful Fan Test. J. T. Beard. Illustrated account of a successful test of a mine-ventilating fan at North Wilkes-Barre, Pa. 1000 w. Eng & Min Jour—Aug. 5, 1905. No. 71228.

Tests of a Capell Ventilator at the Dorstfeld Mines (Untersuchung eines Capell-Ventilators auf Zeche Dorstfeld II-III). Data and results of tests of a ventilating fan delivering 8,000 cubic metres of air, in actual service. 1200 w. Glückauf—July 29, 1905. No. 71545 D.

See Mechanical Engineering, Measurement.

MISCELLANY.

Amber.

Amber in Santo Domingo. Clarence C. Sample. Describes the island and the amber-bearing section, the rocks, and the varieties of amber. 1600 w. Eng & Min Jour—Aug. 12, 1905. No. 71307.

Congress.

The Congress of Metallurgy (Congrès de la Métallurgie). Léon Guillet. A general report of the metallurgical congress held at Liége in connection with the international exposition. Two articles. 6000 w. Génie Civil—Aug. 5, 12, 1905. No. 71520 each D.

Emeralds.

Emerald Mines in Colombia. From a report by Mr. Lloyd-Owen, describing the celebrated emerald mines of Muzo, Colombia. 1300 w. Min Wld—Aug. 26, 1905. No. 71605.

Fluorspar.

Principal American Fluorspar Deposits. H. Foster Bain. Information concerning the Kentucky-Illinois fluorspar district, explaining the uses and value of the different grades. 2000 w. Min Mag—Aug., 1905. No. 71290 C.

Incrustation.

Examination of Incrustation Formed on Rabble Plate of a McDougall Furnace. William P. Headden. Read before the Colorado Sci. Soc. Describes the appearance and gives the analyses made. 1500 w. Min Rept—Aug. 3, 1905. No. 71198.

Petroleum.

The Petroleum Industry of Germany (Die Erdöl Industrie Deutschlands). H. Plock. A general review of the production in Europe, and an account of the refining and manufacturing of lubricants in Germany. 7500 w. Glasers Annalen—Aug. 1, 1905. No. 71532 D.

Phosphate.

Tennessee Phosphate. R. D. O. Johnson. Describes the deposits and methods of mining. Ills. 3500 w. Eng & Min Jour—Aug. 5, 1905. No. 71230.

Salt.

Chamber Workings in Rock Salt Mining (Ueber Bergmühlen im Kalisalzbergbau). H. Kegel. A description of the method of excavating working chambers in the rock-salt mines of the Halle district, with formulas for computing costs. 3000 w. Glückauf—Aug. 5, 1905. No. 71547 D.

Wolfram.

The Wolfram Deposits of New England, New South Wales. Hartwell Conder. Briefly describes this district and the deposits of wolfram, and the occurrence of other valuable minerals. Editorial. Ills. 3000 w. Min Jour—Aug. 12, 1905. No. 71446 A.

Zinc.

Zinc Carbonate Ores of the Magdalena Mountains. Charles R. Keyes. Describes the location, geology, ore deposits, and peculiarities of this region in New Mexico, especially considering the zinc ores. Ills. 2400 w. Min Mag—Aug., 1905. No. 71289 C.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accident.

The Liverpool-Southport Railway Accident. Brief illustrated account of the accident of July 27, explaining the results of the collision. 700 w. Engr, Lond—Aug. 4, 1905. No. 71371 A.

Canada.

How Canada is Solving Her Transportation Problem. Lawrence J. Burfee. Describes the natural features of Canada, its numerous waterways, and the climatic conditions which lead to the population settling largely in the southern part; explains the recent rapid growth and development, showing the importance of transportation facilities, and giving an account of completed and proposed work. 4500 w. Pop Sci M—Sept., 1905. No. 71470 C.

Engineers.

Essential Qualities of a Successful Locomotive Engineer. W. J. Hill. Considers education, experience and good judgment the most essential. 1600 w. Ry & Engng Rev—Aug. 12, 1905. No. 71325.

Great Britain.

A German Impression of British Railroads. Wilhelm Cauer. An account of the features that impressed a railroad engineer from the Continent, while traveling for instruction. 5000 w. R R Gaz—Vol. XXXIX, No. 7. No. 71402.

Notes on British Railways (Mitteilungen von den Englischen Eisenbahnen). W. Cauer. An address before the German Railway Association discussing British terminals and operative methods from a German viewpoint. 4500 w. 1 plate. Glasers Annalen—Aug. 1, 1905. No. 71531 D.

Operation.

The Operation of an Automatically Blocked Single Track Railroad. H. M. Waite. Brief paper on the successful working of this system on the C. N. O. & T. P. Ry. 2500 w. Pro St Louis Ry Club—Aug. 11, 1905. No. 71639.

Private Cars.

An Apology for the Private Car and a Remedy for Its Abuses. A. M. Simmons. Reviews briefly the history of the private car, the circumstances which led to the building of refrigerator cars, the growth of the industry, the present problem, and a suggestion for its solution. 2500 w. Ry & Engng Rev—July 29, 1905. No. 71112.

Train Logs.

Graphic Train Logs. Paul T. Warner. Eplains the method of preparing these interesting records which show all stops and variations in speed on the run. Gives four curves prepared in the manner indicated. 1000 w. R R Gaz—Vol. XXXIX. No. 5. No. 71227.

MOTIVE POWER AND EQUIPMENT.

Brakes.

The Combined Automatic and Straight-Air Brake. R. H. Blackall. Read before the New England R. R. Club. Describes the operation of these brakes and states their advantages. 3300 w. Ry & Engng Rev—Aug. 12, 1905. No. 71324.

The Control of Fast Trains by Brakes. Editorial discussion of the safety in operation of high-speed trains. 1200 w. Ry Age—Aug. 4, 1905. No. 71217.

Buffer-Coupling.

Thomas's Central Automatic Buffer-Coupling. Description of the apparatus, with drawings. 1200 w. Engng—Aug. 11, 1905. No. 71464 A.

Car Loading.

Machine for Loading Box Cars with Coal. Illustrated description of the tilting cradle, invented by S. Kedzie Smith, and its operation. 1700 w. Eng News—Aug. 3, 1905. No. 71180.

Cars.

Covered Goods Wagons for Japanese Railways. Brief illustrated description of a lot of 900 narrow gauge (3 ft. 3 in.) covered goods wagons being built in Chicago for the Japanese Imperial Government Railways. 400 w. R R Gaz—Vol. XXXIX., No. 7. No. 71399.

Delaware & Hudson Composite Coal Car. Illustrated description of composite hopper gondola cars of 80,000 pounds capacity. 400 w. Ry Age—Aug. 4, 1905. No. 71219.

Steel Freight Car Design. C. A. Seley. From an address at Purdue University. Discusses the design of the steel-frame box car. 1400 w. Am Engr & R R Jour—Aug., 1905. No. 71138 C.

The Building of a Railway Car. Day Allen Willey. Illustrated detailed description of the methods of constructing the coaches used on the principal American railways. 1800 w. Sci Am—Aug. 19, 1905. No. 71392.

Locomotives.

A Handsome Passenger Locomotive of 1861. C. H. Caruthers. Drawing and description of an engine rebuilt when materials vere very high. 700 w. R R Gaz—Vol. XXXIX., No. 8. No. 71612.

An "Atlantic" Compound for the Great Northern of England. Illustrations, with brief description. 350 w. Ry Age—Aug. 11, 1905. No. 71300.

Comparative Tests of Steam and Electric Locomotives. An account of the tests made on the experimental track of the New York Central Railroad, giving results. Ill. 1400 w. Sci Am Sup—Aug. 5, 1905. No. 71186.

Details of Argentine Locomotives. Illustrates compound articulated locomotives (meter gauge) for the Central Northern Railway of the Argentine Republic. The engines work on heavy grades up to 1 in 40 and wood is used as fuel. They have many interesting features. 1600 w. Engng—Aug. 4, 1905. No. 71363 A.

Henri Four-Cylinder Compound Express Locomotives—Paris, Lyons and Mediterranean Railway. F. C. Coleman. Illustration, sections and brief explanation of the Henri system of express locomotives. 400 w. Ry Age—Aug. 18, 1905. No. 71410.

Inspection Locomotives, New York Central Lines. Illustrates and describes a combination locomotive and car found to be very useful. General dimensions are given. 1200 w. Ry & Engng Rev—Aug. 26, 1905. No. 71606.

Locomotives at the Liége Exhibition. H. W. Hanbury. Discusses the Belgian and French locomotives exhibited. 4000 w. Engng—Aug. 18, 1905. Serial. 1st part. No. 71630 A.

New York Central Inspection Locomotive. Illustration, with brief description. 150 w. Ry Age—Aug. 11, 1905. No. 71302.

Schenectady Balanced Compound Locomotive for the Erie. Illustrates and describes tvhis experimental engine built for hauling heavy passenger trains on the grades between Jersey City and Port Jarvis. 600 w. Ry Age—Aug. 4, 1905. No. 71218.

Ten-Wheel Switcher for the Lake Shore. Illustrates and describes the heaviest and most powerful engines yet built for yard service. 700 w. Ry Mas Mech—Aug., 1905. No. 71269.

Tests of Superheater Locomotives by the Belgian State Railways. Extract from a paper by J. B. Flamme, read before the Inst. of Mech. Engrs., giving an account of experiments with locomotives combining superheating with compounding. 700 w. Ry Age—Aug. 4, 1905. No. 71221.

The Development of the Freight Locomotive in America. Charles S. Lake. The present article discusses the types of freight locomotives in use and recent freight engine practice. Ills. 1200 w. Prac Engr—July 28, 1905. Serial. 1st part. No. 71248 A.

Motor Cars.

American Gasoline Railway Motor Cars. Illustrates and describes the Union Pacific's gasoline car, and the gasoline electric car of the St. Joseph Valley Co. 1800 w. Sci Am—Aug. 26, 1905. No. 71484.

The Union Pacific Motor Car No. 1. Illustrated description of a single-truck, four-wheel car, designed for light branch and interurban service. The motive power is a six-cylinder gasoline engine of 100 horse power. 1300 w. Ry Mas Mech—Aug., 1905. No. 71268.

Oil Fuel.

Oil Fuel for Locomotives. Howard

We supply copies of these articles. See page 159.

Stillman. Deals with the California deposits, the calorific values, specifications for fuel oil adopted by the Harriman Lines, method of burning, tests made, and related matters of interest. 5000 w. Pro Pacific C Ry Club—July 15, 1905. No. 71292 C.

Speed Tests.

High-Speed Trials with Steam Locomotives (Schnellfahrversuche mit Dampflokomotiven). Data and results of recent trials of steam locomotives upon the Marienfelde-Zossen experimental track. 1800 w. Glasers Annalen—Aug. 1, 1905. No. 71533 D.

Steam Car.

The Peebles Steam Rail-Car. Illustration and description of a new type of steam car for branch line traffic. 1400 w. Tram & Ry Wld—Aug. 10, 1905. No. 71476 B.

Stores.

The Store Department. C. F. Balch. Outlines the needed equipment of a railroad store, considering the facilities, organization and operation. 2000 w. Ry Age—Aug. 4, 1905. No. 71220.

Traverser.

Traverser for the Western Railway of France. Illustrates and describes a new type, designed by M. Dubois, which is light and strong, easy of operation, and designed to transfer rolling-stock from one curved track to another. 1000 w. Engng—July 28, 1905. No. 71252 A.

NEW PROJECTS.

New Line.

The Nile-Red Sea Railway. Map and information concerning the line generally known as the Suakin-Berber Railway. 900 w. Engr, Lond—July 21, 1905. No. 71170 A.

The Northwestern's New Line to Milwaukee. Map and description of a line under construction for relief of the existing lines of the Chicago & Northwestern. 1500 w. R R Gaz—Vol. XXXIX., No. 6. No. 71312.

Rhodesia.

The Rhodesia Railways, Limited. An illustrated description of the railway from Vryburg to the Zambesi and beyond. 2800 w. Eng Rec—Aug. 26, 1905. Serial. 1st part. No. 71616.

PERMANENT WAY AND BUILDINGS.

Location.

Locating a Railroad Line Through a Forest. J. A. Macdonald. Describes the method of getting from one controlling point to another in a rough and difficult forest country. 700 w. R. R. Gaz—Vol. XXXIX., No. 5. No. 71225.

Mountain Railway.

A Unique Colorado Mountain Railway. An interesting description, with map, of this very remarkable railway which reaches an elevation of 10,000 feet. 1200 w. Ry Age—Aug. 18, 1905. No. 71411.

New Plant.

The New Plant of the Louisville & Nashville R. R. Co. at South Louisville, Ky. Illustrated description of a new plant for repair and construction of cars and locomotives, which aimed to have the very best arrangement and equipment for carrying on the work. 5500 w. Engr, U S A—Aug. 1, 1905. No. 71231 C.

Portable Plant.

Electric Plant for Fixing Rails and Packing Permanent Way. Illustrates and describes a portable plant used on some of the French railways for permanent-way construction and repair. 900 w. Engng—Aug. 11, 1905. No. 71462 A.

Quincy Road.

The Quincy Granite Road. S. Harry Ferris, in *Four Track News*. Information of the road, three miles long, built to convery the granite for the Bunker Hill monument, and said to be the first American railroad. Ills. 1100 w. Ry & Loc Engng—Aug., 1905. No. 71136 C.

Rails.

The Creeping of Rails on Railroads. N. Benjamin. Gives an explanation of the creeping which seems to the writer to be the harmony with mechanical laws and supported by experiment. 1900 w. Ry Age—Aug. 4, 1905. No. 71222.

Rail Sections.

Rail Sections as Engineering Structures. P. H. Dudley. Read before the Am. Soc. for Test. Materials. Discusses this subject showing the mportance of the material in the rail, and the problems in the manufacture of rails for present service. Ills. 1500 w. Ir & St Mag—Aug., 1905. No. 71314 D.

Railway Curves.

An Important Problem in Railway Curves. Antonio Llano. Gives a problem of constant occurrence in railroad work, especially in the location of street railway curves, and the solution which the writer considers simpler than those usually seen. 300 w. Eng Rec—Aug. 26, 1905. No. 71618.

Regulations.

English Board of Trade Regulations for Track, Bridge and Signal Work. Gives the requirements governing new construction of railways as relating to signaling, interlocking, passenger stations, bridges, track and switch work. 3000 w. Ry & Engng Rev—Aug. 19, 1905. No. 71414.

We supply copies of these articles. See page 159.

Station.

Denver & Rio Grande Station at Grand Junction, Colo. Drawings and description of a somewhat unusual station of pleasing appearance. 350 w. Ry Age—Aug. 25, 1905. No. 71600.

Terminal.

Lackawanna's Eastern Terminal at Hoboken. An illustrated detailed description of the proposed station and ferry house, which will take the place of the recently burned structures. Plate. 2700 w. Ry Age—Aug. 25, 1905. No. 71499.

Workshops.

Northeastern Locomotive Works, Darlington. Illustrates and describes these very large works and their equipment. 1200 w. Engr, Lond—Aug. 18, 1905. No. 71638 A.

TRAFFIC.

Clearance.

Comments on Recent Criticisms of Clearance Proposals. J. W. Midgley. A reply to criticisms on a series of articles by the writer, outlining proposed clearance plans. 4000 w. Ry Age—Aug. 18, 1905. No. 71413.

Demurrage.

Reciprocal Demurrage Laws. Ashley J. Elliott. Speech before the Chamber of Commerce, Decatur, Ill. 3500 w. Pro St Louis Ry Club—Aug. 11, 1905. No. 71640.

Freight.

Handling Fast Freight on the Santa Fe. Information in regard to the system in use on this line for handling high-class and special freight—known as the Red Ball system. 1600 w. R R Gaz—Vol. XXXIX., No. 8. No. 71613.

The Frisco System of Handling Time Freight. An explanation of the present time freight system, giving forms used, and general information. 3000 w. R R Gaz—Vol. XXXIX., No. 7. No. 71401.

MISCELLANY.

Charter.

New Jersey Had the First Railroad Charter in the World. An account of an act passed in the New Jersey legislature, Feb. 6, 1815, creating a company to erect a railroad from the River Delaware to the River Raritan. The road was never built. 1600 w. Ry & Loc Engng—Aug., 1905. No. 71137 C.

Finances.

The Relative Finances of British and American Railways. W. Pollard Digby. Aims to show the relation which the respective railway investments in the United Kingdom and United States bear, both as regards capital and revenue, to the respective populations and external commerce. 4500 w. Engr, Lond—Aug. 11, 1905. No. 71467 A.

Oriental Railways.

Railway Strategy in the Orient. George Ethelbert Walsh. Brief discussion of the importance of railways in the commerce of the Orient, and also for war purposes. 2000 w. Ry Age—Aug. 18, 1905. No. 71412.

Railway Congress.

International Railway Congress. A general review of the seventh International Railway Congress which met in Washington. 1700 w. Engr, Lond—July 21, 1905. Serial. 1st part. No. 71167 A.

STREET AND ELECTRIC RAILWAYS

Accidents.

Accidents and Injuries in Street Railway Operation (Ueber Betriebsstörungen und Unfalle im Strassenbahnverkehr). F. W. Bork. A review of the operation of the street railway system of Berlin, discussing the wear and tear, and the losses and injuries by accidents; with discussion. 3500 w. Glasers Annalen—July 15, 1905. No. 71534 D.

Why Accidents Happen. Dr. H. B. Rockwell. Discusses the main causes of accidents on electric railways. 3500 w. St Ry Jour—Aug., 1905. No. 71207 C.

Bogie Cars.

Four Motors v. Two. Robert N. Tweedy. Notes on tests reported in a recent paper before the Am. Inst. of Elec. Engrs., in New York, with remarks on cost and economy in operation. 2800 w. Elec Rev, Lond—July 21, 1905. No. 71156 A.

Cars.

The Cars of the New York Subway (Die Wagen der New Yorker Untergrundbahn). S. G. Freund. Describing especially the Gibbs steel cars; also the wiring and general electrical arrangements. 6000 w. Elektrotech Zeitschr—Aug. 3, 1905. No. 71561 B.

Control.

The Johnson-Lundell Regenerative Control for Tramcars. Illustrates and describes the latest Johnson-Lundell-

We supply copies of these articles. See page 159.

Land regenerative, double series, paralleling, automatic braking control system for electric tramcars. 1800 w. Elec Engr, Lond—Aug. 4, 1905. No. 71355 A.

Draw-Bars.

Some Experiences with Draw-Bars for Electric Cars. W. T. Van Dorn. Gives facts from the writer's experience, showing that it is not wise to use a draw-bar lighter than 3 ins. x 3 ins. stem. Also discusses couplers. Ills. 2700 w. St Ry Jour—Aug. 12, 1905. No. 71299 C.

Freight.

Freight Development by Interurban Roads. E. F. Siexas, in the *Railway and Shipping World.* Gives an account of the success on the Niagara, St. Catharines & Toronto Railway, a steam line originally, but changed to electricity, and concludes that the freight business of interurban lines will pay if confined to the higher class of traffic, and attention is paid to dispatch and accommodation of the public. 2500 w. Ry & Engng Rev—Aug. 12, 1905. No. 71323.

Interurban.

Improvements to a Toledo Road. An illustrated account of the extensive improvements to the system of the Toledo, Bowling Green & Southern Traction Company. 5000 w. St Ry Jour—Aug. 12, 1905. No. 71298 C.

Metropolitan.

Metropolitan District Railway. Illustrated description of some of the rolling stock equipment and traffic arrangements. 3500 w. Tram & Ry Wld—Aug. 10, 1905. No. 71475 B.

New Zealand.

The Installation of Electric Tramways in Christ Church, New Zealand. James Drummond. Illustrated detailed description of a complete electric railway system built under the auspices of the municipality. 2200 w. St Ry Jour—Aug., 1905. No. 71206 C.

Overhead Equipment.

The Prevention of Overhead Accidents. Robert N. Tweedy. Explains how the safety of the overhead equipment is guarded on one of the large Midland systems. 2200 w. Elec Rev, Lond—Aug. 11, 1905. No. 71457 A.

Paris.

The Construction Works of the Paris Metropolitan (Travaux de Construction des Differentes Lignes du Metropolitan de Paris). Georges Lesourd. A very full account of the recent extensions of the Paris underground railway, bringing the record down to January, 1905. 20,000 w. Mem Soc Ing Civ de France—March, 1905. No. 71594 G.

Power Distribution.

The Underground Distribution of Power for Urban Electric Traction. James Heywood. Read before the Philadelphia branch of the Am. Inst. of Elec. Engrs. Discusses the conduits, high-tension cables, terminals, tests, installation, d. c. cables, return cables, localization of faults, etc. Ills. 3300 w. St Ry Jour—Aug. 19, 1905. No. 71408 C.

Rapid Transit.

Philadelphia's Rapid Transit Railroad. Outlines the general scheme for real rapid transit, and begins an illustrated detailed description of the Market Street subway, now under construction. 4800 w. R R Gaz—Vol. XXXIX., No. 7. Serial. 1st part. No. 71400.

Spokane.

Electric Railways in and About Spokane. An illustrated article giving information of interest relating to the lines receiving power from the Washington Water Power Co. 3000 w. St. Ry Rev—Aug. 15, 1905. No. 71398 C.

Statistics.

The Status of Electric Railways in Germany at October 1, 1904 (Zusammenstellung der Elektrischen Bahnen in Deutschland nach dem Stande vom 1. Oktober, 1904). The yearly tabulated review of electric traction develoment in Germany, with editorial comment. 12,000 w. Elektrotech Zeitschr—July 13, 1905. No. 71554 B.

Stray Currents.

See Civil Engineering. Water Supply.

Tracks.

The Development of Special Track Work on Street Railways. Victor Augerer. From a paper read before the Conn. Soc. of Civ. Engrs. & Surv. Considers some of the problems of street railways and the modern methods for special track work, comprising curves, switches, frogs, etc. 5800 w. Eng News—Aug. 3, 1905. No. 71176.

Valtellina.

New Electric Locomotives for the Valtellina Railway. Bela Valatin. An illustrated account of the latest methods employed on this important three-phase line, and the new equipment. 6500 w. St Ry Jour—Aug. 5, 1905. No. 71205 C.

Operating Results of the Valtellina Railway—Peculiarities of the Three-Phase Traction. Eugen Cserhati. Gives a summary of results in operating costs, current consumption, recuperation of energy, energy consumption, fly wheel effect, etc. 3500 w. St Ry Jour—Aug. 26, 1905. No. 71611 C.

We supply copies of these articles. See page 159.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Air Power. *qr.* New York.
American Architect. *w.* New York.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Am. Iron and Steel Asso. *w.* Phila., U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Review. *m.* Montreal.
Cassier's Magazine. *m.* New York and London.
Cement. *b-m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.

Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Engineer. *w.* London.
Electrical Magazine. *m.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemical and Met. Industry. *m.* New York.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Engineering Review. *m.* London.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Far Eastern Review. *m.* Manila, P. I.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Strassenbahnen. *s-m.* Berlin.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Metallurgist. *m.* Boston.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Magazine. *m.* New York.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Page's Weekly. *w.* London.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Pacific Coast Rwy. Club. *m.* San Francisco.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Public Works. *qr.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Railway and Loc. Engng. *m.* New York.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Street Railway Journal. *w.* New York.
Street Railway Review. *m.* Chicago.
Tijds v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
World's Work. *m.* New York.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Elektrotechnik. *w.* Vienna.